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Finding a Safe and Just Space for Water Use in Mexico City

An Evaluation of Mexico City's Water Public Policies with Doughnut Economic Sustainability Transitions Criteria

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Abstract

Mexico City's water system is not sustainable. There is an unfair inequality gap in the quantity and quality of water access for its residents. Moreover, the groundwater aquifers in the city are being over-exploited and polluted. This has resulted in the sinking of the city, damage to the ecosystems, and the reduction of water access to Mexico City's residents. As the policies are a direct instrument of the governments to transform the systems, this research aimed to find support tools that analyzed and strengthened the degree to which sustainable transition elements are included in Mexico City's local policies. For this, a sustainable evaluation was made with the minimum sustainable criteria to guarantee the human right to water and to ensure a minimum ecological water flow of Mexico City's basins. This sustainable criterion was based on Raworth's (2019) Doughnut Economics Model but translated from a planetary focus to an urban water sector focus. For the methodology, the theory of change of the status quo policies was compared to the one required for a sustainable water model scenario of the city, to understand the sustainable transitions degree of the policies. The results from this comparison showed there are ongoing, missing, and threatened transitions. This means that there are different stages of the transition still required in the current and future Mexico City's water policies. For this reason, this research proposed policy recommendations about how to include these sustainable transition elements in the policies in three stages. Moreover, it proposes to use this Raworth's sustainable criteria as a clear basis to set a sustainable goal in different contexts, and the impact evaluation to understand what elements in the process are required to get to the sustainable scenario goal within each context.

Keywords: Sustainable Transitions, Mexico City, Water Use, Doughnut Economics, Impact Evaluation, Policy

Executive Summary

Problem Definition

Mexico City is one of the most populated cities in the world. Even though the city was built on a lake, its current water resources are not enough to supply sufficient water to its 9 million citizens while assuring the protection of its groundwater over-exploited aquifers. For this reason, there is the need to understand in what way there can be a sustainable transition of its water system to solve its social and ecological water challenges.

Aim, Research Questions, and Methodology

To do this, this research has the main assumption that the policies are the main tool for sustainable transitions change, as they are the instrument of the State to make transformative changes in the systems. Hence, the research aim was to make a sustainable evaluation of Mexico City's water policies, based on Kate Raworth's socio-ecological systems approach, to understand which elements are still required for this transition. As a methodology, it used the impact evaluation methodology to analyze the theory of change or logical chain of the policies. Its three research questions were:

1) What are Mexico City's 2018-2024 water public policies?
2) What can be the socio-ecological criteria, based on Raworth's Doughnut Economic Model, to evaluate whether Mexico City's 2018-2024 water policies are transiting to sustainability?
3) What is the sustainable transition state of Mexico City's 2018-2024 water public policies?

Findings

For the first question, the results found that there exists a sustainable Mexico City's 2018-2024 water policy. This water policy focused on two elements: guarantee the human right to water and reduce the over-exploitation of the aquifer. For the second question, it was found then that the sustainable criteria meant defining goals for these two elements, as well as instruments to get to these goals. For this reason, it was found that the human right to water was mainly defined in the Mexican Constitution in Article 4 (Estados Unidos Mexicanos, 2021) as the social foundation criterion, and the minimum ecological flow as the environmental ceiling criterion.

Taking these criteria, the results of the evaluation showed that through this methodology, there exist defined social and ecological borders of Mexico City's water system. These borders can serve as the minimum goal for the policies to transit towards development. However, the borders are not sufficient to understand the possibilities or mechanisms of the system for the transition. Therefore, an impact evaluation was done to show the different logical elements and instruments of the system that the policy could use to transit towards sustainability.

Discussion

In this impact evaluation, it was shown that in Mexico City's water policies, there are three degrees of sustainability transitions:

- Ongoing Sustainability Transitions
- Missing Sustainability Transitions
- Threats to Sustainability Transitions

Moreover, there seems to be several steps for this transition to reach the sustainable borders of the system. The first stage of this transition is to finish the implementation of the policies

that have already been planned and that have already started to be implemented. The current policies with sustainability characteristics that have started to be implemented have acknowledged the importance to reduce the over-exploitation of the aquifer, and a better redistribution of the water resources. For this, the current policies have planned to make new measurement units called sectors to understand where the water problems are, both concerning quality and quantity. They have already begun making measurements by sector of the new local "sectors" units.

The second stage is to start implementing the only yet-planned policies. This is because there are implementation obstacles. This will require making infrastructure and consumption changes in those places where there are currently water issues. For this, the policymakers have understood that they need greater trust from civilians as well as better coordination with other public institutions. Finally, even when the water issues have been recognized by the policymakers, the third stage consists of including these missing sustainable transition elements in the policies. Some of these elements are reducing the consumption of water in the city and increasing the trust of civilians when making infrastructural changes.

Moreover, these results showed that it is possible to apply the doughnut economic model approach to specific sectors within a city, including the water sector as seen in *Figure 0-1*. This is useful as it gives a sustainable transition scenario contextualized to a particular time and place. It gives the goals of how that system would look like if it was sustainable. Also, this research found that it could be useful for this model, when changing its scale, to have a different basis for the social foundation aspect of the model. This social foundation would have a stronger basis if it were based on the locally applicable human rights instead of its policies.

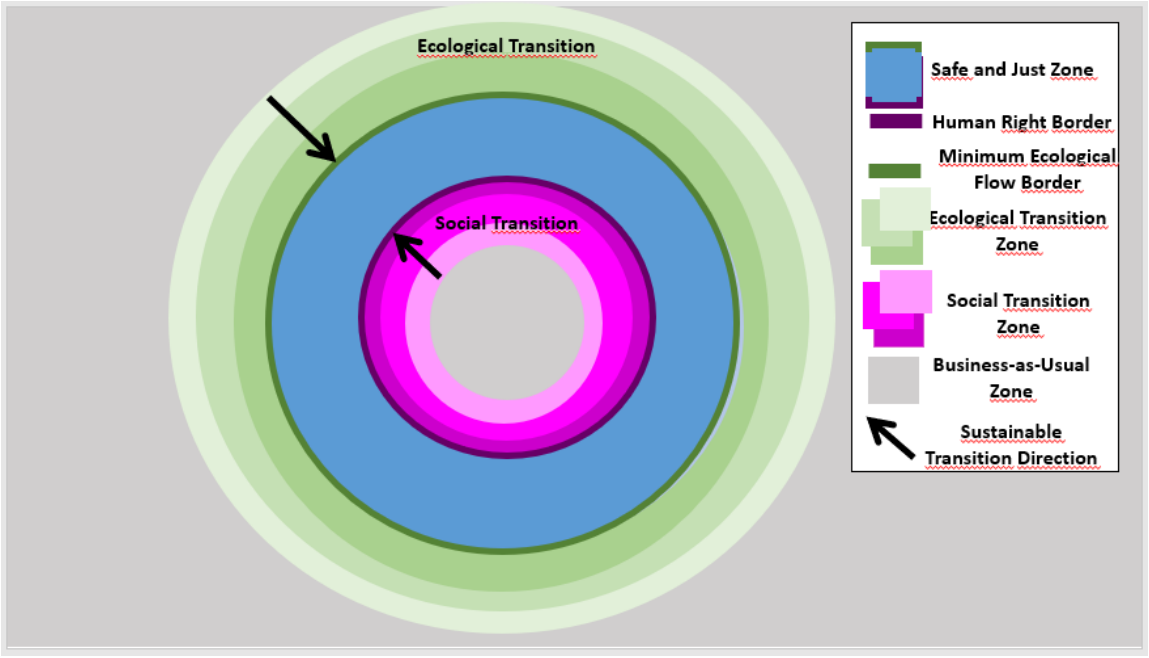

Figure 0-1 Mexico City Water' Sustainable Transitions Model

Source: Own creation

Conclusion

From these results, this evaluation showed that Mexico City's water policies have partially included the socio-ecological elements of its system required for a sustainable transition according to Raworth (2017). There are then at least three transition stages that Mexico City's policies require to get into the sustainable zone of Mexico City's doughnut water system:

A) Finish the implementation of the currently planned policies.
B) Implement other planned policies with elements for a sustainable transition.
C) Plan policies of the sustainable transition elements not yet included.

Mexico City is now on the first of these stages and still requires two other stages. Thus, this research proposed the following policy recommendations in these three stages:

Table 0-1- Policy Recommendations

STAGE 1 - Finish the implementation of the current sustainable transition planned policies.	**STAGE 2 - Implement other planned policies with elements for a sustainable transition.**	**STAGE 3 - Plan policies of the sustainable transition elements not yet included.**
Finish the macro-measurement of the inputs-outputs of water	**Create trust and partnerships with society.** **Make model scenarios that include the analysis of the water cycle elements of the Pánuco, Lerma-Santiago basin, as well as have this information from the other hydrological basins where Mexico City gets its water from.**	**Create agreements about what can be done when tariffs are not paid.** **Increase projects that include multi-stakeholder investments and participation.**
Prioritize infrastructure maintenance and repair over the creation of new water sources infrastructure.	**Implement the water restoration projects.** **Close the water wells where there is low water quality.**	**Increase of water infiltration to the aquifers.** **Decrease gradually the water imports from other hydrological basins.**
Finish the reordering of the water uses, including promoting treatment water	**Increase the rainwater and treatment water projects.**	
Incentivize future long-term public administrations to continue with a socio-ecological water perspective	**Coordination between governmental institutions at different levels**	**Promotion of the national human rights water law.** **Professional capacity development.** **Transparency of information.**

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Abbreviations

Basin's Commission – Comisión de la Región Hidrológico-Administrativa XIII (Basin's Commission of the XIII Hydrological-Administrative Region).

BAU – Business-as-Usual System

CDMX – Ciudad de México (Mexico City)

CONAGUA – Comisión Nacional del Agua (National Water Commission)

CPCDMX – Constitución Política de la Ciudad de México (CPCDMX)

CPEUM – Constitución Política de los Estados Unidos Mexicanos (Constitution of the Mexican United States Political)

ICESC – International Commission of Economic, Social and Cultural Rights

INEGI – Instituto Nacional de Estadística y Geografía (Mexican National Statistics and Geography Institute of Mexico)

IWA – International Water Association

MEGADAPT – Megacities Water Adaptation

SACMEX – Sistema de Aguas de la Ciudad de México (Mexico City's Water System)

SDGs – Sustainable Development Goals

SE – Secretaría de Economía (Ministry of the Economy)

SEDEMA – Secretaría del Medio Ambiente de la Ciudad de México (Mexico City's Ministry of the Environment)

SEMARNAT – Secretaría del Medio Ambiente y Recursos Naturales

UNAM – Universidad Nacional Autónoma de México (National Autonomous University of Mexico)

WWF – World Wildlife Fund

1 Introduction

"We can't control systems or figure them out, but we can dance with them."
- Donella Meadows, Thinking in Systems

Sustainable Development has been defined as the "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). It is a perspective that intends to change the economically focused *BAU* system we currently live in, to one that includes considering our current and future environmental and social needs. One of the vital human needs recognized by development is water (Committee on Economic, Social and Cultural Rights, 2003; Gleick, 1999). However, drinking water is a limited resource. Therefore, there has been an international acknowledgment of the "Water Decade from 2018-2028" to transit towards water sustainability (Secretary General, 2017). This requires the understanding of what it would mean to have a sustainable water use in each context, so that the future generations can still benefit from this resource.

According to the governance approach recognized by sustainability, different actors must participate in the implementation of sustainability (Jaeger & Conference Sustainable Development: a Challenge for European Research, 2011, p.82). However, States are the main responsible agents for implementing sustainability, as has been recognized in the international sphere with the *common but differentiated responsibilities principle* in the Agenda 2030 (General Assembly, 2015).

One way in which the States can make this transition is through policy, as the way the executive branch of the three state powers can act. The other two ways are related to the judicial and legislative powers branches (Möllers, 2013). As the executive branch is the one that can then create projects for this transition in the short term, but it requires an analysis of the future needs, this research aims to find a tool that supports current policies in this transition towards sustainability for the future.

In Mexico City, there are several social and environmental issues in the water sector. On one side, there is an inequality gap between the personal and domestic water use of different municipalities in the city (Alma Rosa Huerta Vergara & Pedrozo Acuña, 2018; Delgado Ramos, 2013). On the other side, there is increasing water pressure in the hydrological basin where Mexico City is located, and also in the other water basin systems where it gets its water from (Izazola, 2001). This means that there is still not a sustainable system in place in the sixth most populated city in the world. However, the current government has the political will to implement sustainability (Gobierno de la CDMX, 2019; Presidency of the Republic, 2019). Thus, defining what sustainability would mean and then evaluating the accomplishments and areas of opportunities for implementing sustainability in the water system in Mexico, can be useful to transit Mexico City and other similar cities to a sustainable transition. **Finding the elements of how to support policies to reach a safe and just space for Mexico City's water system is then what this research aims to do.**

1.1 Background – Mexico City's Sustainable Water Policy Challenges

Mexico City is the capital of Mexico. It is a city that was previously a lake and that had several superficial rivers (Legorreta, 2012). Now, it has been transformed into one of the world's most populated cities (World Population Review, 2021) with its rivers inside pipes. Also, there is an

increasing demand for water supply that the hydrological basins have not been able to support. Consequently, Mexico City imports water from other basins with the help of one of the largest potable water systems in the world (*Cutzamala System*, n.d.), the Cutzamala water system. All these characteristics of the system result in the following social and environmental challenges of water in Mexico City that the 2018-2024 policies must face.

Mexico City's Water Challenges – Unjust water space.
Mexico City is recognized as one of the most populated cities around the world. Its population, according to INEGI (National Institute of Statistics and Geography, 2021) is 9.2 million people. This population is distributed unequally across the city (National Institute of Statistics and Geography, 2020), and has different socio-economic characteristics. Not all the water for this population arrives from Mexico City's hydrological basins, it also comes from other basins. It also does not reach the eastern part of the city. Thus, there is an unequal water distribution (Izazola, 2001) that results in an unfair water space for Mexico City's residents.

Mexico City's Water Challenges – Unsafe water space.
The quality and quantity of water in Mexico City's water basins is decreasing (Agustín Felipe Breña Puyol & José Agustín Breña Naranjo, 2007; Izazola, 2001). At the same time, there has not been a joint understanding of the ecological water processes and the water systems. There are increasing floods in the city due to rainwater, while there is a lack of water in the city (Izazola, 2001). Moreover, as the way to increase the water supply has been through the extraction of groundwater, this has increased the plunging of the city. Thus, the current water management is increasing ecological risks instead of benefitting from the ecological characteristics of the city. As the government is the public owner of the water according to the Mexican Constitution in its Article 27, Mexico City's citizens demand that public authorities solve these socio-ecological challenges of the water in Mexico City. For this reason, these are the challenges that the governments should solve, and a way to do so is through its policies.

1.2 Justification – Transiting to Sustainability through Policy

Policies are one instrument of States to respond to its social and environmental challenges. As States are the main agent for sustainability, they are the ones that can make then greater sustainability transition changes to solve these challenges. Hence, there is the need to find how policies can include sustainable transitions in them. Three ways exist to analyze a sustainable transition (Loorbach et al., 2015):

1. Mapping the current sustainability challenges in a system to know the best pathway.
2. Find sustainability criteria for a society's future.
3. Formulate the areas that require changes from the mentioned criteria.

Thus, these three ways could be useful to support the policies to transit towards sustainability. For this analysis, it is required then a theory to understand what the sustainability challenges are, as well as to know how there can be transformative changes that address these challenges. For this, the doughnut economic model will be used as the criteria to understand the challenges, and the policy process as the procedural tool to create areas for sustainability transition changes that respond to Mexico City's sustainable water transition challenges.

1.2.1 Doughnut Economics as a model and goal to transit towards sustainability

Sustainability is a systemic proposal of a transformative change that requires data to know how it can be implemented in each context. One of the ways of how to characterize this

system is through a socio-ecological systems approach. However, even when there are also many interpretations of socio-ecological systems to transit towards sustainability, not all of them have been implemented outside of the academy. One of the interpretations that have started to be used outside of the academy, and that is linked to sustainability is the sustainable doughnut (Göpel, 2016; Raworth, 2017) explained in *Chapter 2*.

The Sustainable Doughnut shows the vision of what a sustainable scenario should look like. Thus, it is a framework that can help us define a sustainable system in different contexts. This makes it different than other sustainable theories that are already characterizing the sustainable goals under generalized, or political/interest-based assumptions. Thus, understanding the sustainable scenario of each system within the doughnut's theory, makes it a comparable and more scalable way of framing the system, while allowing the creation of unique context-based solutions. The doughnut allows us to describe the socio-ecological elements (social foundations, and environmental ceilings) still required to achieve this system's sustainable transformation, and the challenges and opportunities this would entail.

Raworth's (2017) interpretation of a socio-ecological system was made at the international level. It defined the social foundations as the SDGs that are part of the Agenda 2030 (General Assembly, 2015) and the Environmental Ceilings as the Planetary Boundaries by Steffen (Rockström et al., 2009). However, this doughnut is now also started to be applied at the national, local, and city levels (Raworth, n.d.-a).

1.2.1.1 Knowledge Gap

There are currently 24 known cities that have started to apply this doughnut approach to their policies (International Development LSE, 2021). However, even when Mexico City is one of the places where there could be more impact as it is one of the densest cities in the world, there has not yet been the inclusion of this perspective for its urban planning. Therefore, this research intends to fill this research gap by applying this theory to Mexico City's policies.

Moreover, even when the sustainable doughnut vision has started to be applied at the urban planning scale in other countries, it has not yet been used at the sector level. For this reason, there is still no understanding of the inner challenges of each ministry to achieve these sustainable doughnut goals. Even when there is the need for an integral analysis, there is also the need to start from one perspective to work on concrete actions to achieve the doughnut economics proposal. This research then intends to find a way to use the doughnut at a policy sector level, to understand what sustainability means for Mexico City's water.

Finally, the current proposal of the Doughnut Economics Model is using policies as its social foundation. However, policies are dependent on the political will, instead of on the social agreements in particular locations. Thus, this research proposes also to advance knowledge for the doughnut theory, and test whether it is useful to use other social foundations instead of policy.

1.2.2 Mexico City's Policies as a tool for transformative action

In Mexico, the public administration has the main responsibility and capacity to make the changes required in the State to guarantee the human right to water and to manage the water resource. As the policies are the main tool for the public administration, then improving the policies assures greater support for the transition towards a sustainable water system.

1.2.2.1 Mexican Policies Responsibility for Sustainable Water

As the Mexican Constitution states in its Article 4 Paragraph 6 (Estados Unidos Mexicanos, 2021) and 27 Paragraph 1, the State is the authority responsible to guarantee the human right of access to water and to manage the water resource. These articles establish that there are multi-level authorities involved in this. Therefore, the authorities at different government scales must work together to understand how to face their responsibility towards the guarantee of the human right to water while limiting the freshwater resources use. As the policy is one of the main instruments that authorities must make transformative changes in their systems/states, the policy at different scales must be analyzed.

Moreover, Mexico City's 2018-2024 water policies emphasized that they aimed to "**guarantee the water right and reduce the overexploitation of the basin, integral improvement of the sewer and sanitation**" (Gobierno de la CDMX, 2019)**.** This is a policy included under the Urban Plan Axis of "sustainable city", and the sub-theme of the axis of "Environment and National Resources" (Gobierno de la CDMX, 2019). Hence, as it describes this policy as creating sustainable and integral management of the resource, this suggests that there is interest in Mexico City for sustainable water policies.

1.2.2.2 Policies Transformative Capacities for Sustainable Water

To transit towards sustainability, tools are needed to create transformative action. This means creating innovation that is "helping to shift existing systems towards a new pattern of viability better suited to the future" (Graham Leicester, p.20). The ways to make transformative change are: 1) Knowing, 2) Imagining, 3) Being, 4) Doing, 5) Enabling, 6) Supporting.

Policies are considered as one of the instruments within the *enabling* stages of transformation. This is because they are required as the interface between innovation and infrastructural systems. For this, there is the need for "policy frameworks for system transitions (…) to enable a transition from the dominant mode of operation in a large, complex public system to a new pattern fit for the future, over time, while ensuring that operations do not fail in the process" (Graham Leicester, p.88). Thus, an analysis of the policies and their opportunities for change may allow enabling transformative sustainable changes for the systems.

1.2.2.3 Knowledge Gap

The policies are an instrument that can be used by the government to transit towards sustainability. In the case of Mexico City, there is a clear political will to do this. However, there are still many sustainable challenges that the government has not been able to solve. For this reason, one way to face these challenges is first by defining clearly what would it mean for Mexico City's water system to be sustainable. The second way to face them is to find policy support mechanisms that can transit the current system into its sustainable scenario. As Mexico City is the sixth most populated city around the world, and there is a current trend in cities to grow (United Nations, 2018), it could also serve as a comparative example for other cities.

1.3 Research Questions

For this reason, this paper aims **to evaluate whether Mexico City's 2018-2024 water public policies are transiting towards sustainability defined in terms of Raworth's (2017) Doughnut Economics Model.** Three research questions guide my analysis:

1) **What are Mexico City's 2018-2024 water public policies?**

The first research question will analyze Mexico City's 2019-2024 water public policies. It will include the understanding of these policies, their goals, and developments until 2021.

2) **What would be the sustainable transitions criteria to evaluate whether Mexico City's 2018-2024 water public policies are transiting to sustainability?**

This second research question seeks to identify clear criteria to evaluate the policies. For this, it aims to identify what would be the characteristics of a sustainable scenario for Mexico City's water sector, based on Raworth's (2017) model. This means understanding how to translate the planetary social foundations and ecological ceiling for Mexico City's water case. Also, it will try to find a way in which these criteria can be used to evaluate the water public policies.

3) **What is the sustainable transition state of Mexico City's 2018-2024 water public policies?**

The final research question will then evaluate the policies sustainable transition state with the socio-ecological criteria.

1.4 Scope and Delimitations

1.4.1.1 Time and Space

Mexico City, as the political entity, will be the geographical delimitation. Moreover, the analysis will focus on the policies of the period of 2018-2024 at the local scale. Even when there exist also some applicable national and international policies for Mexico City, the analysis will focus on those created by the local Mexico City's government and its institutions.

1.4.1.2 Socio-ecological System

There are different systems thinking approaches to understand what sustainability means. In this research, Mexico City's system will be characterized as a socio-ecological system. The characteristics and limitations of the system will be set by Raworth's systems thinking theory and will be described in the Literature Review Chapter in more depth. The elements, interactions, and feedback loops will be analyzed. However, an in-depth analysis of the stocks and flows will not be analyzed due to time and reference constraints.

1.5 Audience

There are mainly three agents that can use this research:

1) ***Researchers*** interested in understanding: a) Water challenges in urban settings; b) The human right of water and freshwater resource use challenges of Mexico City. c) Methodologies to downscale the Doughnut Economics Model.

2) ***Policymakers*** interested in water policy improvement in Mexico City, and in other cities with similar challenges. This would include national, local, and municipal policymakers interested in a socio-ecological approach for their policies.

3) ***Advocacy agents for sustainability,*** which would consist of NGOs, think tanks, research institutes, or individuals interested in promoting and operationalizing ways for sustainability transitions. This includes the Doughnuts Economics Action Lab which is a platform for people interested in applying Kate Raworth's theory.

1.6 Ethical considerations

This research design has been reviewed against the criteria for research requiring an ethics board review at Lund University and has been found to not require a statement from the ethics committee.

1.7 Disposition

The **Introduction** describes Mexico's unsustainable water system. It describes its social and environmental challenges. Then, it explains how the policies are useful to transform the system and transit it towards sustainability. For these reasons, it explains how the current research intends to evaluate the current policies to analyze what elements can States include in their policies to transit Mexico City's water system into a sustainable one.

The **Literature Review** describes the two elements required to transit towards sustainability in policy: a theory of what does sustainability means, and a policies' process required for it. Sustainability is then defined within the goals of the Doughnut Economics Model. Then a way to analyze the policy process is described: the theory of change impact evaluation tool.

The **Methodology** Chapter describes the policy impact evaluation research design. Then it describes the methods used for data collection of the literature review and the semi-structured interviews. Later, it describes the method of coding used for data reduction. Finally, it explains the method of qualitative content analysis for the data analysis and describes the materials collected.

The **Findings** Chapter answers the three research questions. For this, it describes the content of the local water policies in Mexico City to answer RQ1. Then, it explains what the identified criteria were to make the policy evaluation to answer RQ2. Finally, it shows the evaluation of the current Mexico City's water system policies against the human rights guarantee and freshwater resource use, to answer RQ3. By doing this evaluation, it will show the progress of Mexico City's water policies in a sustainable water transition.

The **Discussion** describes the original aspects in this research regarding: a) the theoretical elements of sustainable transitions that could be included in the theoretical framework of Raworth's Doughnut Economic Models, b) how the impact evaluation can be used as a policy support tool for sustainable transitions, and c) what are the elements of what elements were found to miss in Mexico City's water policies to transit towards a sustainable system.

The **Conclusion** has three parts. The first part summarizes the answer to RQ1, RQ2, and RQ3. Afterward, it explains the policy recommendations of how to introduce the sustainable transition elements that were found in the research into the policy. Finally, it further suggests future research related to the gaps of knowledge found throughout the research.

2 Literature Review – Transition of Sector Policies towards Sustainability

The Literature Review Chapter will explain how there are sustainable transition theories and policy impact evaluation theories, that can be used together to find innovative support mechanisms for sector policies to transit towards sustainability. For this, the first part of the chapter will describe what sustainable transitions theories are, from the general systems thinking approach to the specific Doughnut Economic Model. It will show how they have created frameworks to understand what sustainability transitions can mean in different policy contexts, but they are still missing tools for sector analysis and have not yet added a human rights approach.

In the second part of the chapter, the process of the policies will be highlighted to find support mechanisms for sector analysis. For this, it will be shown how the evaluation policy stage seems to be the most useful to find what should be changed in future policies. In Mexico City's water policy case, there is only a previous evaluation made of 2012-2018 water policies. It did not take fully into consideration all sustainable aspects. For this reason, this literature review shows the knowledge gap of making a more complete sustainable evaluation that can understand the processes required for a sustainable transition for Mexico City's 2019-2024 water public policies.

2.1 About Sustainability Transitions in Policy

Transitions are "the result of **co-evolving processes** in economy, society, ecology, and technology that progressively build-up toward a revolutionary **systemic change** on the very long term" (bold made by the author of this research) (Loorbach et al., 2015, p. 49). As in this case we are analyzing sustainability in the water policies of Mexico City, the co-evolving processes are understood as the policy processes, and the systemic change as the policy sustainable model goal for water, that can promote incremental changes (Climate KIC, n.d.; Loorbach et al., 2015).

As described, **sustainable transitions have then two main characteristics:** they are **a) systematic change,** which is done through **b) co-evolving processes**. There will be a description of what do we mean by these two characteristics for this research, by analyzing the relevant literature and its knowledge gaps. The systemic change refers in this case to what are the different meanings of sustainable transitions within the literature from a systems thinking approach. Meanwhile, the co-evolving processes, as this case study focuses on sustainable water policies, are the tools of policy to transit towards this sustainability.

2.2 Systematic Change for Sustainability

Systems thinking are one of the main characteristics of sustainability(Capmourteres et al., 2019). However, there are different ways to understand sustainability according to systems thinking as will be explained below.

2.2.1 Systems Thinking

Systems have been defined as "a set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviors, often classified as its function or purpose" (Wright & Meadows, 2008, p.188). This definition

includes then three things in a system: "elements, interconnections and a function or purpose." (Wright & Meadows, 2008, p.12) It is a perspective of understanding the world in a more integral manner rather than the common view of analyzing only one aspect of it. Systems thinkers "see the world as a collection of stocks along with the mechanisms for regulating the levels in the stocks by manipulating flows." Thus, systematic thinking requires the understanding of a system by analyzing its parts (Wright & Meadows, 2008):

- Elements
- Interconnections
- Purposes
- Stocks
- Flows

Regarding the parts of the systems, there is one main way to understand the **interconnections** of the elements of sustainability systems. This is by the understanding of the **feedback** loops within a system. A feedback loop is described as the "basic operating unit of a system" (Wright & Meadows, 2008, p.5).

In comparison, there are different ways to understand the **elements, purposes, stocks and flows** for sustainability. Three approaches of systems thinking are dominant when speaking about a sustainable transition (Loorbach et al., 2017). Each of these three approaches shows innovative ways to understand the systems and processes required for a sustainable transition. They all intend to break the path dependencies that exist in current *BAU* systems and provide alternative disciplinary and epistemological understandings of the systemic challenges and their solutions. These three main approaches are (Loorbach et al., 2017):

4. **Socio-Technical**. This approach is based on science and technology. It is focused on the understanding of regime structures, external landscape pressures, and emerging niches of the dominant technologies. This approach is mainly used for sectors where infrastructure and technology are relevant, including energy, mobility, and water (Loorbach et al., 2017)

5. **Socio-Institutional.** This approach is mainly based on social science and politics. It aims to understand the cultures, structures, and practices where transitions take place. It gives a more social dimension of the change required for sustainability transitions. This is generally a more qualitative, action-oriented approach (Loorbach et al., 2017).

6. **Socio-Ecological.** This approach is based on ecology and resilience theory. It seeks to understand the (in)stability in ecosystems while observing their social aspects. For this, it analyzes the system's vulnerability and its transformative capacity (Loorbach et al., 2017). This approach has helped to link the dynamics of environmental and social change. The socio-ecological approaches have been linked to sustainability directly, and have been recognized to have already achieved (Fischer et al. 2015): (1) increased recognition of the dependence of humanity on ecosystems; (2) improved collaboration across disciplines, and between science and society; (3) increased methodological pluralism leading to improved systems understanding; and (4) **major policy frameworks considering social-ecological interactions.**

As this research intends transformative action for sustainability, the socio-ecological approach was chosen for the analysis. Therefore, the understanding of the elements, purposes, and interactions of the socio-ecological model will be described below.

2.2.2 Socio-Ecological Models

The socio-ecological models originated from one idea of Elinor Ostrom (Ostrom, 2009), and it has been developing throughout the years by Ostrom herself as well as by other researchers (McGinnis & Ostrom, 2014). She created a model to organize findings of the complex world threats that have been a result of the damage and loss of many natural resources caused by human activity. For this reason, Ostrom proposed a model that understands the systems in a socio-ecological way. This complex systems model is shown in *Figure 2-1*.

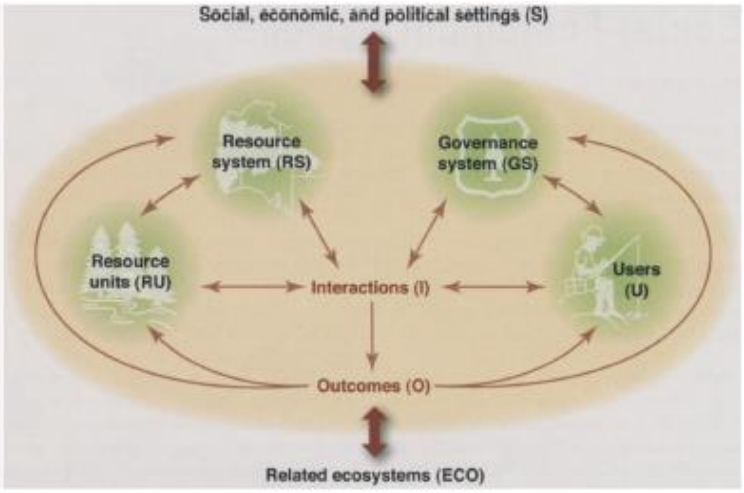

Figure 2-1 - Core subsystems in a framework for analyzing socio-ecological systems
Source: Ostrom, 2009

This model follows the system's thinking perspective (Wright & Meadows, 2008) by including the following parts of the system (Ostrom, 2009):

- **Elements**: Ostrom includes the following four elements: 1) Resource Units, 2) Resource System, 3) Governance System, and 4) Users.
- **Interactions**: They are the links between the internal and external elements of the system that are the related ecosystems and the social-economical-political settings.
- **Purposes:** Analyze sustainability.

However, this model also adds other parts that require to be also considered as shown in *Figure 2-1:*

- **Outcomes**, showing a result-based perspective of the system.

Finally, for Ostrom (2009) the **stocks,** and **flows** are described as second-level variables that are more measurable indicators of the elements of the system. Even when this model showed ways to understand the systems, it did not specify the goal or degree of what the interactions inside these elements should be.

This shows that Ostrom's framework was a descriptive and not normative approach. Thus, it does not allow to propose changes with goal-setting. In comparison, some other perspectives and models have used Ostrom's socio-ecological approach to make a normative sustainable goal. One of these approaches is the Doughnut Economic Model by Raworth (Raworth, 2017), described below.

2.2.3 Doughnut Economics Socio-Ecological Model for Transformative Action

The Doughnut Economics Model was created by Kate Raworth to give a goal that responds to the main challenges we must deal with in the 21st century. This model has been described as a sustainability model and it has been a theory applied to give policy advice. Therefore, it is a theory that can be used as the criteria for the policy evaluation of this research.

2.2.3.1 Doughnut Economics Model

Taking the basis of the socio-ecological systems approach, Kate Raworth developed a normative framework that allowed for transformative change (International Development LSE, 2021). In other words, it tried to apply this socio-ecological theory into action.

The Doughnut Economics proposal was created by Kate Raworth as part of a paper she had to write when working in the international organization of OXFAM (Raworth, 2012). As this model was created as part of practical work, it required a practical use of the theory. Thus, the Doughnut Economics Model is then a socio-ecological proposal that intends transformative action by providing the elements of the socio-ecological system required for sustainability. Even when Raworth (2021) does not mention transitions, she gives a clear picture and goals of what sustainable transitions should mean in principle (Göpel, 2016).

The Doughnut Economics establishes, as its name clearly shows, that the global system is in the shape of a doughnut. It has this shape as there exist minimum and maximum boundaries to the current global system we live in. The internal border consists of the minimum social foundation that must be guaranteed in our system, and the external border consists of the ecological ceiling that we must not surpass (Raworth, 2017) shown in *Figure 2-2*.

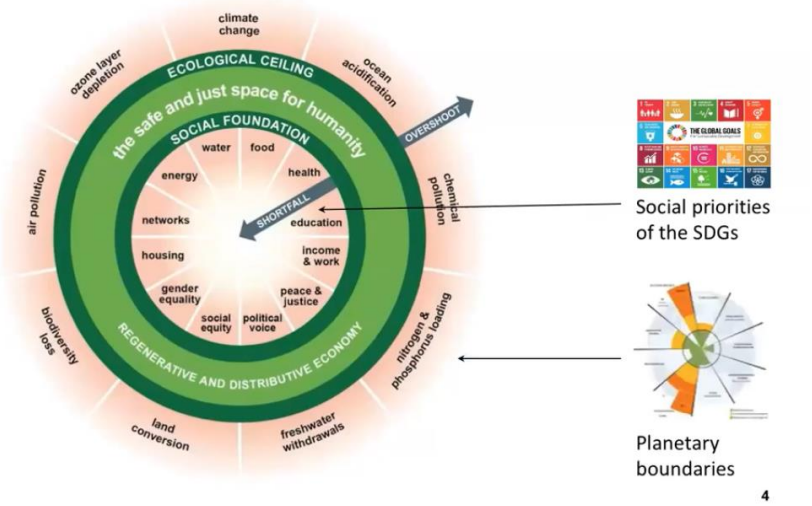

Figure 2-2 – A compass for human prosperity
Source: International Development LSE, 2021

Raworth states that the social foundation consists in "the basics of life on which no one should be left falling short." (Raworth, 2017, p.39). It is based on the SDGs recognized in 2015. They are the 17 goals (United Nations, n.d.). For this case study, the focus will be principally on SDG number 6: Clean Water and Sanitation. However, the SDGs are *a plan of action* made in 2015, to transform the current sustainable challenges to 2030. They are an international political agreement for policies, with the limits of 2015 international political will.

In comparison, according to social contract theories in law and political science (Keeley, 1995; Lessnoff, 1986), human rights have been recognized as the basis of social foundations. This can be seen in the first and sixth paragraph of the Preamble of the Universal Declaration of Human Rights, which states (General Assembly, 1948):

> *Preamble -First Paragraph: "Whereas recognition of the inherent dignity and the equal and inalienable rights of all members of the human family is the foundation of freedom, justice, and peace in the world".*
> *(…)Sixth Paragraph: "Whereas Member States have pledged themselves to achieve, in cooperation with the United Nations, the promotion of universal respect for and observance of human rights and fundamental freedoms".*

For this reason, in this research instead of using the SDGs as the social foundation for the Doughnut Economics Model, we will use international human rights and complementary human rights legal framework at the national and local levels instead.

Meanwhile, the environmental ceiling consists of the planetary boundaries stated by Rockstrom et al. (2009) and updated by Steffen et al. (2015) shown in *Figure 4-3*. For this case study, we would be then mainly interested in the freshwater resource use boundary. This boundary will be more thoroughly explained in *Chapter 4 - Findings*.

The Doughnut is the main goal behind the sustainable transition that Raworth (2017) proposes. However, she also proposes some principles behind this goal. She calls them the *seven ways to think in the 21st century* that will be explained below.

2.2.3.2 Doughnut Economics Systematic Change Proposal

The Doughnut Economic Model does not only propose what would be the goals for a sustainable system with the doughnut. It also proposes ways of how to change the current *BAU* system towards a sustainable one, by changing mindsets. These mindset change proposals described below are also based on other theories that are currently being developed to transit towards sustainability (International Development LSE, 2021).

1) *Change the goal.* Raworth states that the current international goal is economic growth. However, the goal for sustainability should be to achieve "human prosperity in a flourishing web of life" (Raworth, 2017,p.46).

2) *See the big picture.* Instead of understanding our global system as an economic one, the change of mindset would be then to understand how the economy is embedded into societal and Earth's system. This shows the socio-ecological understanding of the system in this theory.

3) *Nurture Human Nature.* The model of a selfish man is the current basis and assumption of the economic systems. However, some examples show that human nature also includes more collective and social values. Therefore, this should also be taken into consideration as assumptions and resources of the model of the system.

4) *Get Savvy with Systems.* The understanding of the current systems is simple and mechanical. Instead, the systems should be analyzed in complexity and dynamism.

5) *Design to Distribute.* One assumption of our system is that it is distributive. However, the current increasing unfair inequality gaps have shown us that it is not. Hence, the distribution should be made by new inclusive system designs.

6) *Create to Regenerate.* The current system's purpose is production. Instead, the proposal proposes that the system's purpose is to give back, to regenerate what it takes from nature. This is related to the circular economy theories, which intend that the material flows taken from nature are given back to nature.

7) *Be Agnostic about Growth.* Today the belief is that growth is necessary for the global system. However, the change in the mindset should be to prioritize other goals for the system, and not care whether there will be an economic growth or degrowth process.

These principles have been applied at different levels. Firstly, Raworth gave some conferences on international platforms, where they were discussing them (Raworth, 2013). Secondly, there was a study made at the national level of the application of the doughnut to over 150 nations, that compared the social thresholds achieved versus the biophysical boundaries transgressed (O'Neill et al., 2018). Thirdly, in a more practical environment, Raworth was a local consultant as part of the Amsterdam city's policy planning in 2020 (City of Amsterdam's Government et al., 2019). Amsterdam's government used the "doughnut to embrace a new model to mend post-coronavirus economy" (Raworth, n.d.-a). Thus, Kate Raworth and Janine Benyus worked in a methodological guide to implement this doughnut for cities' policies, and started to apply it in July 2020 to the cities of Portland and Philadelphia. By November 2020 24 other cities were interested in applying this doughnut approach(International Development LSE, 2021). There have been also some other methodology developments to downscale the doughnut at a regional level, and for private actors (Raworth, 2021b).

2.2.3.3 Doughnut Economics Knowledge Gaps

This shows the increasing interest in using the doughnut to transit towards sustainability in cities and a way of how to implement sustainability transitions into practice. It shows us a clear image of the global system we need to get to, and the mindsets and assumptions that need to change in our system for that. However, as the *doughnut model* intends transformative action, tools are needed.

To this author's knowledge, there are already some tools that have been used to downscale the doughnut. However, this model has not yet been used at a sector level. Thus, it could be created for the water sector as an example. As there is an increasing interest in applying this model at an urban level, Mexico City will be analyzed. Moreover, the doughnut has not included yet human rights as its social foundation. One of the guidelines for living in a world of systems is to make feedback policies for feedback systems (Wright & Meadows, 2008). It is thus the aim of this research to find a tool that can be useful to support the sector policies to transit towards sustainability by including a human rights perspective in it and downscale it to be useful for the policies of one of the most populated cities in the world: Mexico City.

2.3 Co-evolving Processes in Policy

To find tools that can support policies for sustainability transitions of Mexico City's water, we must analyze then what are the co-evolving processes for these policies. The policy cycle is used as a "simplified model of the policy processes" (Jann & Wegrich, 2017). For this reason, the policy cycle and its elements can be used to understand how to analyze these co-evolving processes for sustainable transitions in Mexico City's water policies.

2.3.1.1 About the Policy Cycle

Th policy cycle describes the characteristics of the rational general steps of the policies (Everett, 2003; Jann & Wegrich, 2017). Even when its empirical validity has been questioned, it is a helpful tool to analyze the policy process (Everett, 2003; Howard, 2005; Jann & Wegrich, 2017). The policy cycle includes four stages (Jann & Wegrich, 2017):

1. **Agenda-Setting.-** It is when the policy-makers get together to understand the social problems that are being faced in a particular context and decide then what are the most relevant problems for them at the moment. They then select the problems that will be worked on with the policies.

2. **Formulation and Decision-Making**.- This stage consists of deciding what are going to be the proposals of the policies to respond to the problems encountered. This means that policy-makers decide what are the policies' goals, as well as select the alternatives that best fit these goals.

3. **Implementation.-** This stage is characterized by action. It is the "stage of execution or enforcement of a policy by the responsible institutions and organizations" (Jann & Wegrich, 2017, p.51).

4. **Evaluation and Termination.-** It is the stage that analyzes whether the outcomes of the policy responded to the problems and goals selected to work upon. The evaluation research "forms a separate subdiscipline in the policy sciences that focuses on the intended results and unintended consequences of policies" (Jann & Wegrich, 2017). The evaluation studies can be applied to the whole "policy-making process" (Jann & Wegrich, 2017). For this reason, to understand the process of the results of the policies it is sufficient to evaluate the policy rather than analyze its entire policy cycle.

Hence, even when the policy cycle can be described as the way to analyze the process of the policies, it is sufficient to evaluate the policies to understand their intended results and unintended consequences. Different types of evaluation can be done.

2.3.1.2 Policy Evaluation

A policy evaluation is about "comparing the intended and actual effect of public policies" (Knill & Tosun, 2012, p.175). There are different designs for policy evaluation, depending on the goal of the evaluation, the agents involved, and the scope of it. For these reasons, there are different classifications of policy evaluations that are not mutually exclusive (Gertler et al., 2010; Knill & Tosun, 2012; Vedung, 2012). There are also three types of questions that evaluations can address: a) Descriptive questions, b) normative questions and c) cause-and-effect questions. As the aim is to find the goals and mechanisms for sustainability transitions change for policies, this evaluation would have to answer then normative questions. For this, the design of a type of evaluation called impact evaluation can be used to understand not only the goals but also the processes of the policies, as a tool to understand change. This is because the impact evaluation uses as a main tool a theory of change to understand the policies' processes (Gertler et al., 2010, p.13).

2.3.1.3 Scientific Impact Policy Evaluation – Theory of Change Tool

One of the main aspects of the impact policy evaluation is that it intends to understand the process through which the policies address the problems in their agenda-setting. It intends to understand the logical link between the problem, the goal and the actions proposed to get to this goal. For this, the impact evaluation uses a tool called a theory of change.

The theory of change is "a tool to help you describe the need you are trying to address, the changes you want to make (your outcomes), and what you plan to do (your activities)"(Harries et al., 2014,p.5). It describes the "causal logic of how and why a particular project, program, or policy will reach its intended outcomes". In the policies case, they intend to explain the causal logic of how the government's proposals are responding to the problems they are facing. Different elements are included by authors describing the theory of change, depending on the discipline. Different elements of the theory of change exist in the literature (Gertler et al., 2010; Harries et al., n.d.) The basic elements in a theory of change are (Gertler et al., 2010):

1. *Inputs: "*Resources at the disposal of the project, including staff and Budget"
2. *Activities: "*Actions taken or work performed to convert inputs into Outputs"
3. *Outputs:* The tangible goods and services that the project activities produce (They are directly under the control of the implementing agency.)
4. *Outcomes:* Results are likely to be achieved once the beneficiary population uses the project outputs (They are usually achieved in the short-to-medium term.)
5. *Final outcomes:* The final project goals (They can be influenced by multiple factors and are typically achieved over a longer period.)

Theories of change are based on the assumption that policy-making should be evidence-based (Gertler et al., 2010). However, to the author's knowledge, they have not been used outside the policy discipline, in law, ecology, and systems thinking, even when the elements of the theory of change are similar to the inputs and outputs of the complex thinking. Thus, the theory of change can be used in this research as a logical framework to understand the sustainability goals required of the system, but also the processes to get to that goal.

2.3.1.4 Mexico City's Policy Evaluation Knowledge Gap

There have already been previous impact evaluations that analyze the water policies in Mexico City. From this author's knowledge, the most recent finished evaluation for Mexico City's water policies was made by three researchers from different public and private institutions in collaboration with Mexico City's government in 2010. It consisted of an interdisciplinary evaluation of drinking water access policies in Mexico City (Jiménez Cisneros et al., 2011). This evaluation was developed in two stages (Jiménez Cisneros et al., 2011): substantive evaluation and operative evaluation. The first part of the evaluation intended to analyze the contents of the policies and the alternatives. They analyzed the documents, laws, and diagnostics of the policies. For the second operative part of the evaluation, they analyzed the implementation, follow-up, and some of the projects and programs directly related to inequality water access.

Today, there is a Master Plan assessment that is being conducted that is also focused on drinking water(Pardo, 2019). However, it has not yet been published. From this evaluation and this new Master Plan, there are two parts of the policies that have been analyzed: substantive and operative procedures. Also, this evaluation analyzed water in Mexico City's policy focusing on the inequality aspect, rather than a sustainable or ecological approach. Moreover, it is only analyzing the drinking water access elements, rather than all the ones required to guarantee the human right to water. Finally, no evaluations are analyzing the current government's 2018-2024 Mexico City's water policies.

2.4 Literature Review Conclusion

Sustainability transitions are a systemic change made through co-evolving processes. There are many ways to understand what this systemic change could be. One way is through Ostrom's (2009) socio-ecological proposal that recognizes the existence and linkage of social and ecological elements as the basis for our system. Using this socio-ecological framework by Ostrom, Raworth (2017) then applied it to today's 21st-century challenges on a planetary scale. The result was the creation of a clear goal of what a sustainable planetary system should look like. However, there are two gaps of knowledge for this sustainability system goal.

The first one is related to the Doughnut Economics sustainability model. From this model, the definition of a social foundation given by Raworth, and the indicator that is used by her do not correspond to each other. This is because the social sciences, mainly law and political sciences have acknowledged that there are other stronger social foundations of the world's societies: human rights. Also, Raworth's planetary doughnut model has already been applied to the planetary, national and local urban scales, but not at a sector level.

The second one is related to Mexico City's water policy co-evolving processes required by sustainable transitions. There have only been a partially sustainable evaluation of the previous governmental policies. As the main responsible agents for sustainability are States, and they are the ones that have a higher impact on transformative action, there is greater transformation if they act. Therefore, one policy tool that could be useful to support the sustainable transitions of Mexico City's water sector could be an evaluation that analyzes through a theory of change, what are the sustainability goals of the systems and which are the policy processes still required to get to those goals.

As a result, this research can fill the gap of joining this theoretical sustainability approach by Raworth (2017), with the policy tool of the theory of change to see whether it can create a methodological tool that can support Mexico City's water sector policies, to transit policies towards sustainability. This is because it will aim to find the sustainability goals required for the policies in accordance with this theory, as well as the elements in the policy process that can be transformed for this sustainability transition. It will do it at the sector level and including human rights as a social foundation as they are gaps of knowledge that the doughnut model has not yet filled.

3 Methodology

This Chapter describes the methodology proposed in this research to serve as support for policy makers to find the required elements of Mexico City's water system to transit towards sustainability. For this, the methodology consisted of an evaluation that compared the current policies with the elements required for the sustainability scenario of Mexico City's water system. The materials collected came from literature review and semi-structured interviews. All of this is thoroughly described below.

3.1 Research Design

The methodology of this research was an **evaluation of Mexico City's water policies with a sustainable transition criterion** based on Kate Raworth's (2017) Doughnut Economic model. This evaluation had a sustainability transition criterion that stated that a sustainable system is the one that guarantees the social foundations but does not surpass the environmental ceiling elements of the system. Thus, this evaluation addresses what would the social foundations and environmental ceiling in Mexico City's sustainable water system, and then analyze the degree to which the current policies have policies that face the challenge of a sustainability transition. This is to give new ideas of what is yet missing in policies to transit Mexico City's water system to sustainability.

To do this, a comparative analysis between the theory of change of the current policies and the socio-ecological model is done, to see the similarities and differences of its elements. For this reason, the theory of change is used to make the status quo policies and the sustainability scenario comparable. The theory of change is used to analyze the logic behind each scenario and answer the research questions. There are four steps for this analysis, to answer each of the three research questions as shown in *Figure 3-1*:

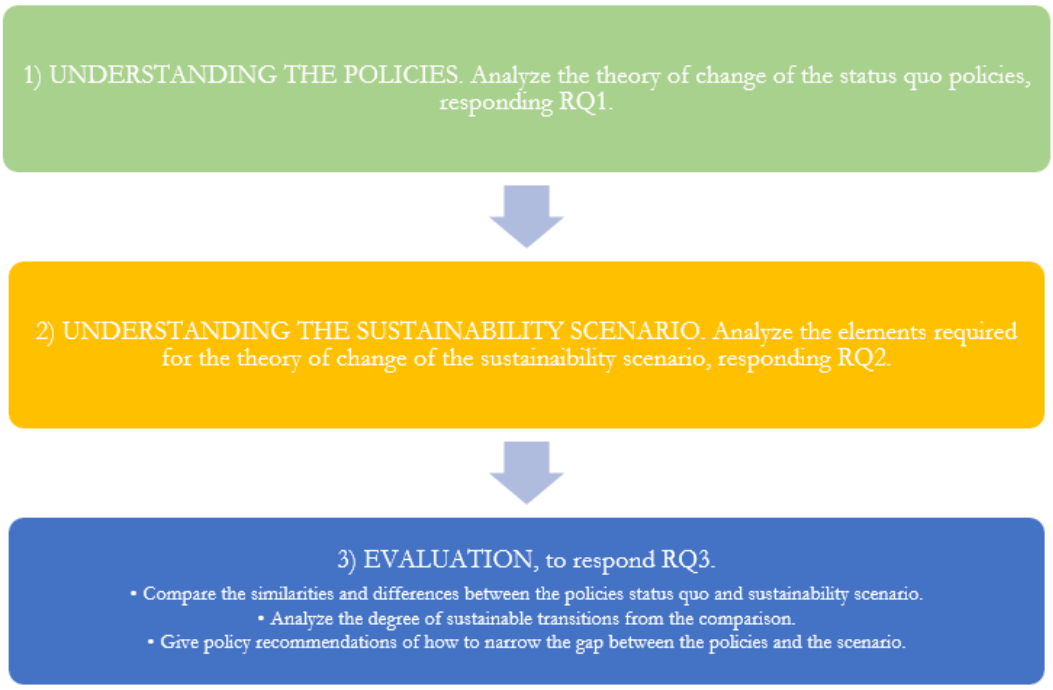

Figure 3-1 - Methodological Steps
Source: Own creation.

The **theories of change analyzed** were about **Mexico City's:**

1. Status quo policies:
    - Water Policies 2018-2024
2. Sustainability Scenario:
    - Human Right to Water
    - Freshwater Resource Use

3.2 Methods for data collection

There were two ways to collect data:

1. Literature Review – To answer RQ1 and RQ2 to understand Mexico City's water policies (for the status quo theory of change), and its legal framework, and ecological and infrastructure water system (for the sustainability scenario).
2. Semi-structured Interviews – To confirm information about RQ1, RQ2 and make the links for RQ3 to make the evaluation. The interviews were used to understand the logic behind the policies, to see the reasons behind the choosing of those policies to face the current Mexico City's water system challenges.

3.2.1 Literature Review

This literature review had the purpose to find the most updated policy and legal documents, official reports, and academic articles and books that give information about the current state of Mexico City's water policies, legal framework, and ecological system. The search included mainly the words: "Mexico City", "water", "policies", "law", and "ecosystem". The search engines used were LUBCAT, CONRICyT, and other official governmental internet pages.

Due to its interdisciplinary nature, it was necessary to delimit the collection of the data. For this, the policy analyzed was limited to: the plans, annual reports, and budget of the governmental institutions that have been publicly published. In respect to the legal documents, they included the sources established by the Mexican Constitution in Article 133, and by using the principle of *lex specialis*. Finally, the most relevant for the ecological system data chosen was from those studies and statistics recognized officially by the State. Then, from these references, a Literature Review Synthesis Matrix was made to extract the relevant information to answer RQ1 and RQ2, a summary of which is included in *Appendixes B and C*.

3.2.2 Semi-structured Interviews

The semi-structured interviews were made to different stakeholders of the water system, including policymakers, lawyers, politicians, and ecologists. Eight semi-structured interviews were intended to be made, but only five were accepted. No interviews with the federal government were accepted, which would give a more integral water management perspective to the study with all the institutions involved. The interviews were 60 minutes long. They were conducted online through Zoom and were transcribed using the online software of Trint (*Audio Transcription Software, Speech to Text to Magic*, n.d.). This transcription software includes privacy regulations for transcriptions.

These interviews focused on complementing the information taken from the literature review to answer RQ1 and RQ2, and to make the linkages of the information to answer RQ3. Each of these interviews tried to increase the information about different stakeholders in the

policies, by asking them their perspectives of how Mexico City's water policies can make a transition towards sustainability. The questions for the interviews consisted of asking what elements of the theory of change were in Mexico City's water policies, law, and ecological system respectively. This depended on the interviewer's specialization. The interview questions are included in *Appendix A*. By asking this varied group of interviewers, this intended to bridge an interdisciplinary science-policy gap and join the information that the experts in different fields already had. It intended to use the data collection to make a holistic understanding of Mexico City's water system and its possible transitions to its sustainable borders. One limitation was that only local policymakers were contacted, as there was no response from the national ones.

3.3 Methods for data reduction

There was one method used for data reduction: deductive coding. It is deductive as the codes were based on the impact evaluation theory of change elements.

3.3.1 Deductive Coding

To reduce the data collected, the theory of change's elements were used as codes. There were some modifications to the original impact evaluation defined by Gertler. One change was that the category or code of "*problem definition*" of the sustainable problem was added. This is because, as Donella Meadows argued, even from a systems perspective there needs to be a problem in mind to understand the system (Wright & Meadows, 2008). Moreover, the category of *goals* was included to show concrete actions or activities of the policies. Also, instead of including *inputs*, we included *policy instruments* recognized as a typology for the types of actions that governments can do (Tojo, 2004). Hence, the elements to reduce the data were the following:

1) *Problem Definition:* These are the challenges that the policy observes for water access that intends to transform through its policies.

2) *Goals.-* These are also called the *Final Outcomes* (Gertler et al., 2010). "The final project goals (They can be influenced by multiple factors and are typically achieved over a longer period). These are also called goals by Vedung (2012).

3) *Policy Instruments.-* They have been defined as "the sets of techniques by which governmental authorities wield their power in attempting to ensure and effect or prevent social change" (Gysen et al., 2002, p.8). Tojo (2004) defines a rationale with three typologies: administrative, economic, and informative used previously to analyze policies (Lindhqvist, 2000). They have been also called "*inputs"* and "*activities*" (Gertler et al., 2010).

4) *Outputs:* "The tangible goods and services that the project activities produce (They are directly under the control of the implementing agency)" (Gertler et al., 2010)

5) *Effects:* "Results likely to be achieved once the beneficiary population uses the project outputs" (They are usually achieved in the short-term) (Gertler et al., 2010). This is also called *"effects"* by Vedung (2012).

3.4 Methods for data analysis

There was one method used for data analysis: deductive and inductive qualitative content analysis. It is deductive as it was based on Raworth's (2017) Doughnut Economic Model to understand what sustainability would mean for the system. However, it was inductive as the content of this research also proposed and tested changes for the Doughnut Economic Theory that could fit Mexico City's water system challenges, and that could also be used when downscaling the doughnut in other case studies. Within this method, comparison tables, flow charts, and diagrams were used to analyze the research.

3.4.1 Deductive and Inductive Qualitative Content Analysis

Qualitative Content Analysis is a "set of techniques for the systematic analysis of texts of many kinds, addressing not only manifest content but also the themes and core ideas found in texts as primary content"(Drisko & Maschi, 2015, p.82). It is deductive as it starts with a theory and evaluating question. It is inductive as it creates changes to the theory based on observed data, to "ensure that the views and voices of research participants are given priority over the ideas and theories of the researchers" (Drisko & Maschi, 2015, p.103). For this reason, the main idea of the sustainable evaluation in this research was to analyze whether the current policies complied with the elements required by Raworth's model (2017) for sustainability. This was a deductive approach, that used comparative tables for its analysis. Then, it analyzed how those policy elements were achieving a sustainable transition. This was an inductive approach that tried to understand how sustainable transitions in policy can be done. For this, this research used flow models and conceptual diagrams for the analysis.

3.4.1.1 Comparison Tables

For the analysis of the data, and to answer the RQ3, a comparison was made between the elements of the theory of change in the status quo policies and the ones from the sustainability model of the system. They were used to assure the same content was compared. This comparison showed what theory of change elements of the sustainability borders were included in the policies, and those that were not. This showed the elements of what has already been accomplished with the policies, and where there is work yet to be done for a sustainability transition.

3.4.1.2 Flow Chart and Conceptual Diagrams

Then, the research used flow charts and conceptual diagrams to show whether there has been a sustainable transition or not. It used conceptual diagrams to show what a sustainable transition would mean, and how the idea could be adapted in Raworth's (2017) doughnut model. It used flow charts to explain the logical movement of the theory of change's elements of the status quo policies and those of the sustainability model. It developed the idea of the Doughnut by passing the planetary doughnut to a sustainable transitions' doughnut, and then to Mexico City's water sustainable transition doughnut.

3.5 Materials Collected

The following types of materials were collected:

1) **Documents:**
    a. *Policies***:** The data consisted of the policy documents applicable to Mexico City's water system. These documents were published by different governmental levels,

and describe Mexico City's water policies between 2019 and 2024. They were found in the official pages of SACMEX, SEDEMA, and CONAGUA (Gobierno de la CDMX, n.d.-b; SEDEMA, n.d.; SEMARNAT, n.d.) and in the Official Federation Journal (Government Ministry, 2021).

b. *Legal Framework*: The data included the laws that served as a basis for the sustainable evaluation of Mexico City's water policies. The sources of law included: 1) international treaties, 2) the Constitution, and 3) Federal laws. It also included other legal documents that were necessary to explain relevant details for the policy evaluation criteria. These were found in two search engines that are useful to search the legal framework applicable at the national and local levels: Legal Counselor and Legal Services of Mexico City's Government (Gobierno de la CDMX, n.d.-a) and the Valid Federal Law (Deputees Chamber, 2021).
c. *Water basin and water system*: The materials included scientific papers, maps, and national surveys that explained and critiqued the freshwater resource use ecological problems in Mexico City. There was a prioritization of those documents that were published by the government, as they were official information (Government Ministry, 2021), as well as some articles in the CONRICyT and LUBCAT search engines.

2) Interviews.

The data will collect information from policymakers of the following institutions to define the problem of water access in Mexico City, and to understand the policies, the legal framework, and the water system boundaries. The research interviewees are shown in *Table 3-1*:

Table 3-1 - Research Interviewees

Name	**Institution**	**Role**
Ing. Héctor González Broc – Planning Director	SACMEX	Policymaker
Mtra. Leticia Gutiérrez - General Direction of Policy Coordination and Environmental Culture	SEDEMA	Policymaker (Coordinator for the creation of the Ministry's public policies)
Dr. Jaime Cárdenas	Institute of Legal Research-UNAM	Lawyer (Previous Deputee and Senator who made the initiative and debated for the human right of water addition at the federal and local levels)
Mtra. Jimena Silva	IWA	Scientist/Biologist.
Dr. Luis Bojórquez	UNAM- MEGADAPT Project.	Interdisciplinary Scientist. Project Leader.

Source: Own Creation.

4 Findings

To make a sustainable evaluation of the policies of Mexico City's water, this Chapter will be divided into three parts:

- **Explanation of what are the current Mexico City's water policies**, and an analysis of what is then its theory of change, responding RQ1.
- **Identification of the criteria to make the sustainable evaluation of the policies**, responding RQ2. The criteria will consist of showing what is the sustainability of Mexico City's water scenario, by showing what are its socio-ecological borders according to Raworth's theory (2017). Also, it will show the theory of change of the scenario, which means the required feedback loops to move the current *BAU* borders to the found sustainable ones. The borders described are from: the social foundation (described by the elements required to guarantee the human right criteria of water), and the ecological ceiling (described by the elements required to assure a minimum ecological flow of the aquifers that give water access to Mexico City's population).
- **Mexico City's Policy sustainable evaluation** by comparing the policies, and the sustainable model theories of change, and then analyzing the degree to which these show a sustainable transition.

4.1 Policies for Water Access in Mexico City

Policies have been defined in their simplest as "a choice made by the government to undertake some course of action" (Engeli & Allison, 2014,p.17). To clarify what is the course of action, Mexico City's water policies 2019-2024 are inscribed in three main types of policy documents. These mainly include, but are not limited to, the following:

- *Government Plans*, that include the government's problem-framing, goals, and policy instruments for the water access policies in Mexico City.
- *Government Annual Reports* that describe what is the development of the water access issues during the implementation of the government's actions. Sometimes they are directly related to the plans, and sometimes they add or delimit the frame of the problem differently as will be seen below.
- *Public Budget,* which describes what will be the amount given by the government to the sector and each of its planned activities.

These documents, listed in *Appendix B* are complementary in some ways and aligned in some others. Depending on the document they can be more general or more specific when addressing the water issues. Each of these documents is created by different institutions. The main institutions responsible for these policies are:

- National Commission of Water (CONAGUA)
- Basin's Commission of the XIII Hydrological-Administrative Region, specialized organ of CONAGUA in Mexico City's regional basins. (Basin's Commission)
- Mexico City's Environmental Ministry (SEDEMA)
- Mexico City's Water System (SACMEX)

Thus, these institutions must work collaboratively but have different faculties to plan and implement the water policies in the city in the short and long term.

Even when each of these policies has logic on its own, there is a general top-down alignment in the policies of what they are trying to change in the water system. This general logic will be described in *Table 4-1* below:

Table 4-1 Theory of Change of Mexico City's Water Policies

	Policies
Problem **(H. González Broc, personal communication, April 15, 2021; L. Gutierrez, personal communication, April 13, 2021; SACMEX, 2020)**	*Ecological*: a) Aquifer over-exploitation and pollution, b) Reduction over time of water supply. *Infrastructural/Technological*: a) Lack of use of treated water, b) non-accounted water hydrants, c) Perspective of water was short-term, d) Missing professional capacity, e) Loss of water due to missing infrastructure maintenance *Social*: a) Lack of continuous water access for all, and b) Inequal consumption of water, c) Lack of society's trust for change *Economic*: Not enough investments in water *Risks*: City plunging and floods.. *Other: a)* Mexico City's water case is unique in the world, b) Water problems connected with other sectors: garbage, land-use change, deforestation.
Goals **(H. González Broc, personal communication, April 15, 2021; L. Gutierrez, personal communication, April 13, 2021; SEDEMA, 2019, 2021)**	There are independent goals from each institution and some other joint goals. From SEDEMA - Rescue of Rivers and Water Bodies - Sustainable Management of Water -Reduce climate change hydrological risks. Two other goals are from the Water System of Mexico City: -Guarantee sufficient but non-continuous good water quality supply for everyone. -Reduce the water supply by $2m^3/s$. -Increase use of treated water. -Self-sufficiency of water supply. The joint goals are: -Guarantee the human right to water and breach the inequality gaps by increasing the distribution of the water supply. -Work coordinately with other sectors and with citizens for the planning. -Long-term political will.
Policy Instruments (Asamblea Legislativa de la CDMX, 2018; H. González Broc, personal communication, April 15, 2021; L. Gutierrez, personal communication, April 13, 2021; *Presupuesto de Egresos 2019*, 2019)	**Administrative.-** *Management:* -Reordering of water uses and creating sectors for water distribution. *Plans:* Master Plans: a) Programs with adaptation and mitigation perspective with a focus on: drainage, water treatment, reuse, and geographically focused. b) Hydrological Integrated Resources General Program. *Institutions:* Limiting the faculties of the different institutions of water, creation of measurements of these sector water flow, c) Coordinated public management between local institutions, d) Capacity building, e) group professionalization., and f) SACMEX is looking for institutional decentralization. *Law:* Legislative harmonization with the new sustainable dogma *Participative Processes* for the document planning.

	Indicators: Future indicators in the PGIRH plan, yet to be published. ***Economic:*** a) Public Budget Investments increases from 13,000 million to 17,000 million pesos (Asamblea Legislativa de la CDMX, 2018; *Presupuesto de Egresos 2019*, 2019), b) planned increase of private financing, and c) water system repair and maintenance. **Informative:** a) Macro-measurement and telemetrics, and b) cultural education: workshops **Infrastructure/Technological.- a)**Restoration Projects, b)treatment Plants, leakages reduction, and c) alternatives of Water Supply: Rainwater catchment.
Outputs (Pardo, 2019, 2020)	From the Governmental Reports the already ongoing activities making sustainable transitions were found to be**:** a) Planning documents, b) Improvement of the quantity, pressure, and quality of the water in 16 municipalities, c) Rehabilitation of wells, d) Increase of water policies for water leakages, e) Conservation projects for basin's recovery, f) Two water treatment plants construction. g) Sectorization division in progress. h) Substitution of water distribution pipes.
Effects **(H. González Broc, personal communication, April 15, 2021; L. Gutierrez, personal communication, April 13, 2021)**	Integral Management for the Hydrological Resources

Source: Own Creation.

For these reasons, Mexico City's water policies consist of all the plans, investments, and actions that have been and will be implemented through these four previously mentioned governmental institutions, that are responsible and that have faculties to propose solutions to the water issues from 2018-2024 in the documents previously mentioned. The focus of these water policies is trying to guarantee the human right water access for all, even when it is not a continuous use, and to start understanding how they can reduce the overexploitation of the aquifer by being self-sufficient (H. González Broc, personal communication, April 15, 2021), and by finding alternative water catchments.

4.2 Criteria for Evaluation: Reach Mexico City's Doughnut Sustainability Scenario

Mexico City's water access policy has the goal to transit towards **sustainability**(SEDEMA, 2019). This is shown as Mexico City's government has included sustainability as part of its policies, as one of the guiding principles of Mexico City's policies, and also as one of its six-axis (Gobierno de la CDMX, 2019). Thus, sustainability for these policies is not only a principle for the city but also a goal.

To understand sustainability, Mexico City's policies define it according to the Brundtland Report: "the development that satisfied the needs of the present without compromising the capacity of future generations to guarantee their own needs." (World Commission on Environment and Development, 1987). It is described as an "ethical" definition (Gobierno de la CDMX, 2019), and as an "urban an economic model" (Gobierno de la CDMX, 2019). They have included Sustainable Development as it "represents the opportunity and the commitment with the future of the city and its citizens" (Gobierno de la CDMX, 2019).

However, even when sustainability is recognized as a principle and an axis for the water access policies for Mexico City, this principle is not operationalized in the policy. There is no clear definition of what it would mean to be sustainable for each sector. Also, it does not give clear indicators of how to reach this goal. Therefore, the policies have an unclear sustainable goal.

For this reason, a concrete idea of what sustainability could concretely mean was found in the Literature Review with the Doughnut Economic Model. Thus, the criteria chosen for the evaluation of the policies was made by adapting the planetary doughnut model, to one that would fit Mexico City's sustainable challenges. For these reasons, the criteria chosen was to evaluate whether the current policies are achieving the goal of getting closer or reaching the sustainability scenario characteristics defined by Mexico City's water system doughnut model. These characteristics mainly consist in two parts: social foundation criterion (which in Mexico City it can be translated to guaranteeing the human right to water) and the environmental ceiling criterion (which in Mexico City it can be translated to not surpass the minimum ecological flow of the hydrological basins where Mexico City gets its water from). Moreover, this evaluation's criteria include the understanding of the logic behind both these parts, or "borders of the doughnut", through their theory of change. These two characteristics will be defined below:

4.2.1 Social Foundation Evaluation Criterion – Human Right to Water

The social foundation criteria used by Raworth (2017) was based on the SDGs. However, SDGs are international policies that do not exist at a local level. Moreover, the public policies have not been considered by social scientists as a social foundation of humankind (Committee on Economic, Social and Cultural Rights, 2003). They have been considered as technical instruments of governments. In comparison, other social creations have been recognized as social foundations. An international understanding of a social foundation has been human rights. Human rights are the basis of the social contracts of a State (Keeley, 1995). They are recognized in the constitutions of countries and further described in detail in the legal frameworks of each country, State, and city. Thus, the human right to water of Mexico City's citizens can be then used as the social foundation evaluation criteria for policies at different levels. For this reason, the characteristics of this human right to water are described below.

4.2.1.1 About the Human Right to Water

Human Rights are the basic guarantees that law gives to individuals. The causes for their existence include: a natural right, a public right, and the existence of international agreements that have recognized these needs from the Human Rights Universal Declaration in 1948 (General Assembly, 1948). However, even when the causes of this right are debated, what has been internationally agreed is that they must be guaranteed for every person, and that that they are the basic obligation that States have towards their citizens, to assure their dignity by securing their basic needs (General Assembly, 1948).

Due to the historical development of these human rights, they have been grouped into three generations (Domaradzki et al., 2019): a) *civil and political rights*, b) *social, economic, and cultural rights*, and c) the *people's or solidarity* rights. Some of these third-generation rights include: environment, peace, development, and from 2012 it has also included the international recognition of the human right to water (Committee on Economic, Social and Cultural Rights, 2003). This human right to water recognition was a result of the interpretation of the existence of this right in Articles 11 and 12 of the Covenant on Economic, Social and Cultural Rights of the United Nations (Committee on Economic, Social and Cultural Rights, 2003).

After this right was recognized by the international community, this strengthened the idea of countries such as Mexico to include this right within their legal systems (Cámara de Diputados, 2012), which is analyzed below.

4.2.1.2 Mexico City's Human Right to Water Use

Four different legal sources serve as legal pillars for Mexico City's human right to water: Constitution, International Treaties, Federal and Local Laws. These are complemented with Jurisprudence to understand how these laws have been applied and enforced. Each of these sources has different descriptive details of what the human right means and of what are different levels of its compliance. These sources will be summarized below and described in more depth in *Appendix C*.

4.2.1.2.1 Constitution

The Constitution has five main articles that regulate water: Article 4 Paragraph 6 and Article 27 Paragraph 1, Article 73 Paragraph XVII, 115 Paragraph III, and 122 of the CPEUM (Estados Unidos Mexicanos, 2021). The first article describes the water human right. The second article emphasizes water as a resource. The other articles establish that water is a sector that requires the coordination of different governmental levels. The first two of these articles will be explained below as they are the basis of the water management system in Mexico:

On the one hand, Article 4 Paragraph 6 states (Estados Unidos Mexicanos, 2021):

> *Article 4 (…) Paragraph 6:* ***Every person has the right*** *to access, disposition, and sanitation of water for personal and domestic consumption in sufficient, salubrious, acceptable, and accessible.* ***The State will guarantee this right*** *and will define the basis, supports and modalities for the access and equitable and* ***sustainable*** *use of the hydrological resources, establishing the participation of the Federation, the federal entities, and the municipalities, as well as the participation of the citizenship for the achievement of these goals.*

This article highlights the four characteristics of the human right to water: 1) the right is for personal and domestic consumption of all, 2) the human right includes quality and quantity of the water and the services related to it, 3) the State is the main responsible agent to guarantee this right but has a governance role, and 4) there are two principles for its management: equitable and sustainable.

On the other hand, Article 27 Paragraph 1 of the Constitution (2021) states:

> ***Article 27****. The* ***property of land and water within the*** *limits of the national territory corresponds from origin to the Nation, which has had and has the right to transmit the control of them to individuals, constituting private property.*

As the Constitution is the "Supreme Law" of the nation, these articles show the main criteria of the goals of the human right of water for Mexico City, too. They give a notion of the rights but also the main basis of the system in which those rights can be guaranteed. They show that there is the acknowledgment of a human right to water as well as a resource management perspective of the water in Mexico at the national level.

4.2.1.2.2 International Treaties

There are treaties at the regional and international level that include regulations about what should be the water characteristics of the human right to water. The most relevant international human rights regulation is Comment 15 of the General Assembly (Committee on Economic, Social and Cultural Rights, 2003), which was itself based on the responsibility of states to guarantee human rights established in (General Assembly, 1990). This is the most relevant treaty as it was recognized as the basis of the State when developing its human right to water (Cámara de Diputados, 2012; J. F. Cárdenas Gracia, personal communication, April 2, 2021).

In this Comment 15 (Committee on Economic, Social and Cultural Rights, 2003), the human right to water is recognized as vital and defined as a "social and cultural good" (Committee on Economic, Social and Cultural Rights, 2003, paragraph 11) that has to be "adequate for human dignity, life, and health" (Committee on Economic, Social and Cultural Rights, 2003, paragraph 11). For this, there is the need to create effective policies and legal frameworks based on three water factors shown in *Figure 4-1* according to the World Health Organization Guidelines. Three of these factors are mentioned in Comment 15 and another factor has been interpreted recently as a separate factor, to guarantee this right (Committee on Economic, Social and Cultural Rights, 2003, paragraph 12).

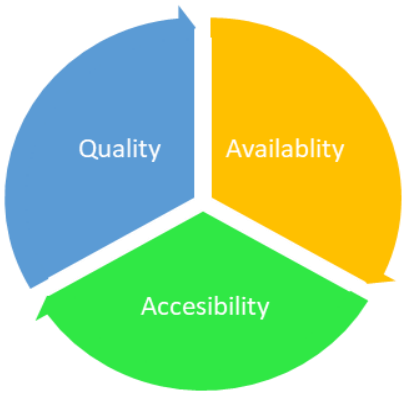

Figure 4-1 - Characteristics of Human Right to Water
Source: Own Creation

These three factors include the following:

- **Availability**: The water should be "*sufficient* and *continuous* for personal and domestic uses. These uses include drinking, personal sanitation, washing of clothes, food preparation, personal and household hygiene." (Committee on Economic, Social and Cultural Rights, 2003, paragraph 12a) The quantity should be "in accordance with the WHO guidelines" (Committee on Economic, Social and Cultural Rights, 2003, paragraph 12a). In these guidelines, it shows four different levels of access to water for people according to the average total daily water consumption of them, shown in *Table 4-2* below:

Table 4-2 - Service level descriptors of water in relation to hygiene (l/c/d – liter per capita per day).

Service level	Distance/time	Likely volumes of water collected	Public health risk from poor hygiene	Intervention priority and actions
No access	More than 1 km / more than 30 min round-trip	Very low: 5 litres per capita per day	**Very high** Hygiene practice compromised Basic consumption may be compromised	**Very high** Provision of basic level of service Hygiene education Household water treatment and safe storage as interim measure
Basic access	Within 1 km / within 30 min round-trip	Approximately 20 litres per capita per day on average	**High** Hygiene may be compromised Laundry may occur off-plot	**High** Provision of improved level of service Hygiene education Household water treatment and safe storage as interim measure
Intermediate access	Water provided on-plot through at least one tap (yard level)	Approximately 50 litres per capita per day on average	**Low** Hygiene should not be compromised Laundry likely to occur on-plot	**Low** Hygiene promotion still yields health gains Encourage optimal access
Optimal access	Supply of water through multiple taps within the house	100–200 litres per capita per day on average	**Very low** Hygiene should not be compromised Laundry will occur on-plot	**Very low** Hygiene promotion still yields health gains

Source: *Domestic water quantity, service level and health* (supporting document in Annex 1)

Source: World Health Organization, 2011

Today Mexico City's average water consumption in Mexico City is 320 liters per capita per day. This means that there is an over-consumption of water. However, the problem is that the consumption is quite unequal as can be observed from *Table 4-3 below.*

Table 4-3 - Examples of Mexico City's Unequal Water Consumption (Municipalities with more and less water consumption)

Municipality	***Population***	***Total Cost* (Liters per second)***	***Endowment (liters per capita per day)***
Iztapalapa	1,783,535	4,746	235
Milpa Alta	96,922	451	410
Average	540,841.5	1958.68	350.93
Total	8,653,464	31,339	5615

Source: Own Creation.

- **Quality.** The water must be safe, this means "free from micro-organisms, chemical substances and radiological hazards that constitute a threat to a person's health" (Paragraph 12b). It should also "have an acceptable color, odor, and taste for each personal or domestic use" (Paragraph 12b). However, Mexico City's water is very polluted as the sewage is combined with the drinking water. (H. González Broc, personal communication, April 15, 2021; National Research Council, 1995)
- **Accessibility**. This means that the water must be accessible to "everyone without discrimination, within the jurisdiction of the State party" (Paragraph 12c). This accessibility has four "dimensions":

    - **Physical Accessibility** (Paragraph 12-c-i).- This means the "water facilities and services must be within safe physical reach for all sections of the population". This means also in the "immediate vicinity". However, in Mexico City, there is a lack of public hydrants, and the water is not continuous. Therefore, sometimes the government must bring pipes of water (J. Silva Pastrana, personal communication, April 5, 2021).

    - **Economic Accessibility** (Paragraph 12-c-ii).- The water must be "(…) affordable for all. The direct and indirect costs must not compromise or threaten the realization of other rights". This element has now started to be included even as an individual factor as seen from the most updated Guidelines of the World Health Organization (World Health Organization, 2011). However, in Mexico City, there is an issue with fair tariffs for all (J. F. Cárdenas Gracia, personal communication, April 2, 2021), and also of the guarantee of the right to water even when tariffs are not paid (Tribunales Colegiados de Circuito, 2017).

    - **Non-discrimination** (Paragraph 12-c-iii).- The water and its facilities "must be accessible to all, including the most vulnerable or marginalized group of the population." There should not be unfair discrimination. However, there are great differences in Mexico City of water consumption between municipalities, that have been related to the water availability and services in them (J. F. Cárdenas Gracia, personal communication, April 2, 2021; H. González Broc, personal communication, April 15, 2021; SEDEMA, 2021) as seen in *Table 4*.

    - **Information Accessibility** (Paragraph 12-c-iv).- It means "to seek, receive and give information about water issues." There are now information campaigns about water in SEDEMA and SACMEX of how to "take care" of the water(SEDEMA, 2021). However, they never speak about reducing water consumption or comparing Mexico City's use with other locations to create water conscience.

This right is recognized as being the responsibility of the State. This responsibility must respond to six obligations:

- **General obligations**:

    1) Guarantee that the right will be exercised without discrimination of any kind.
    2) Take "deliberate, concrete and targeted" steps towards the full "feasible, and practicable" realization of the right to water (Paragraph 17 and 18).
    3) Move as expeditiously and effectively as possible towards the full realization of the right (Paragraph 18).

- **Specific obligations**: There are three main obligations that States must guarantee the right to water (Paragraph 20):

    1) ***Respect***.- States parties "refrain from interfering directly or indirectly with the enjoyment of the right to water (Paragraph 21).
    2) ***Protect***.- States must prevent third parties from interfering in any way with the enjoyment of the right to water (Paragraph 23).
    3) ***Fulfill.-*** It includes three types of obligations "to facilitate, promote and provide" (Paragraph 25).

As can be observed, this interpretation in General Comment No. 15 is now the most descriptive approach to what a human right to water is, and it has been recognized as such also by the Mexican State at the federal and local levels (Cámara de Diputados, 2012)(J. F. Cárdenas Gracia, personal communication, April 2, 2021). This General Comment expressly and clearly describes: 1) what does the human right of water include, 2) who is the responsible agent, and 3) how this human right can be guaranteed. Thus, this General Comment gives clear notions of what the goals of the policies should be not only quantitatively but qualitatively. It gives a general understanding of the water goals internationally, but it does not show the local problems at Mexico City's level. Therefore, this would be also required to analyze.

4.2.1.2.3 Federal Laws

Even when there is no federal law that directly regulates the human right to water in Article 4 paragraph 6 of the Constitution, there is the Law of National Waters. It states in its Article (Cámara de Diputados, 1992) that it regulates:

> *"….**National Waters;** it is of general observance in all the national territory, its dispositions are of public order and social interest and it has as **purpose to regulate the exploitation, and use of those water, its distribution, and control, as well as its quantity and quality, to achieve its integral sustainable development**". Therefore, this is the main law that describes the governmental water system in place that is supporting the State's responsibility to guarantee this right.*

This law establishes Mexico City's legal water system, as well as the principles and policy instruments of how authorities at the federal and basin level can guarantee the human right to water in the policies, and what are these authorities and their faculties. It can be observed that the management rather than the characteristic of water as right is highlighted in this law. This is because there should have been a new federal law regulating the human right to water in Article 4 of the Mexican Constitution. However, even when it was a legal order, it has not yet been made. Moreover, as shown in *Figure 4-2,* the authorities that are recognized in this law to have the State responsibility to guarantee this right, at the federal and basin level are (Cámara de Diputados, 1992):

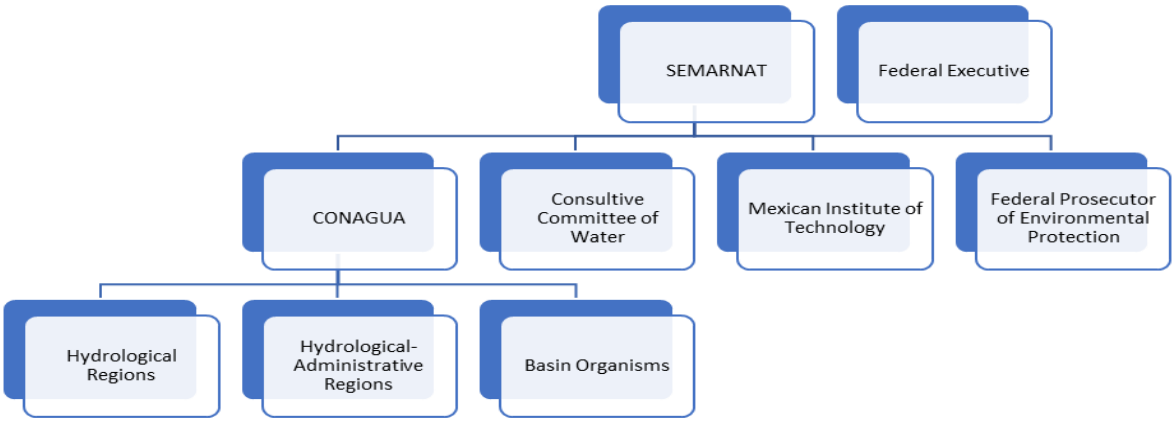

Figure 4-2 - National Water Sector Organigram
Source: Own creation based on the Law of National Waters (Cámara de Diputados, 1992)

The principles that the national hydrological policy must follow are (Deputees Chamber, 1992, Article 14 bis 5):

- The water is a good of "public federal domain, vital, vulnerable and finite, with social, economic and environmental value, whose preservation in quantity, quality and sustainability is a basic obligation of the State and the Society, as well as priority and national security matter (Article 14 Bis 5 Paragraph I).
- Water Management is done cooperatively between different governmental levels.
- The State regulates the uses in the hydrological basins.
- There should be integrated management of the hydrological resources.

Finally, there are also some policy instruments of how the authorities can translate these principles into action (Deputees Chamber, 1992, Article 14, bis 6):

- Hydrological Planning
- Concessions and Assignations
- Management of National Waters
- Charging of "rights" caused by the exploitation, use, discharge, and protection of water.
- Participation of the society's organizations and users.
- Conflict Resolution Mechanisms
- Social Supports for marginalized communities.
- National Information System.

In conclusion, this federal law shows that the evaluation of the policies at this level would be done from a management and not from a human rights perspective at the federal level, as it has not yet been regulated. Moreover, it shows that there are different federal and basin authorities with different faculties over the water resources that should be coordinated. Thus, the law gives the principles for better management of the resource. Also, it gives the elements of the system that should be used in the policies as instruments: the institutions and their faculties, as well as the officially recognized policy instruments to make the changes in the policies. However, it does not give the express criteria of the goals to the human right to water at the federal level.

4.2.1.2.4 Local Laws

At the local level, water is mainly regulated by the Constitution of Mexico City and the Law for the Access, Disposition, and Sanitation of Water in Mexico City. The human right to water regulation at the local level includes a more detailed description than the one at the national level and adds that there should be integral water planning. It also adds some faculties to the government regarding hydrological infrastructure and wastewater (Mexico City's Government, 2008, Article 9; Mexico City's Government, 2017, Article 1,3,5). The main goal is stated in Article 9 Part F of Mexico City's Constitution:

> *Paragraph F. Right to water and its sanitation*
> *1. Every person has the right of access, disposition, and sanitation of sufficient, salubrious, safe, affordable, accessible, and quality water for personal and domestic use in an adequate form to dignity, life, and health; as well as request, receive and spread information about water issues.*
> *2. The City will guarantee universal water coverage, daily, continuous, equitable, and sustainable access. The catchment of rain water catchment will be incentivized.*
> *3. The water is a public, social and cultural good. The water management will be public and non-profitable.*

Moreover, there are more detailed tools to demand this right from the government. Similarly to the national level, the two main topics discussed when creating this law were: governance of water management and water coordination with other public institutions (J. F. Cárdenas Gracia, personal communication, April 2, 2021).

For this reason, it can be observed that there is the same goal of the international and national human right to water at the local level, but there it is more detailed by describing the management of water as integral. However, the responsibility of the state is limited to the public services of drinking water, drainage and sewage, treatment, and reuse of residual waters. Therefore, the local level regulation would delimit the social foundation criteria for the policies to the infrastructural actions that the authorities could do for a sustainable transition. Also, even when the law is used as the sustainable criteria, it will not promote the greatest sustainable changes. This is because the regulation itself has not made a great sustainable transition on its own. Law should then also be modified for sustainable transitions.

4.2.1.2.5 Jurisprudence

There are 31 jurisprudences linked to a "human right to water" (Suprema Corte de Justicia de la Nación, 2021). From this, 12 apply to Mexico City. These show that there exist issues that have not guaranteed the human right to water of people in Mexico City yet, and that there is an existing tool to enforce these rights. These cases are related to: non-discriminatory water access (Tribunales Colegiados de Circuito - Constitucional, Penal, 2014; Tribunales Colegiados de Circuito, 2014), consequence when households do not comply with water tariffs (Tribunales Colegiados de Circuito - Constitutional, Administrativa, 2015), conflictual water uses (Tribunales Colegiados de Circuito - Constitucional, 2015), prioritization of the domestic and personal use over others, minimum of 50 liters per capita (Tribunales Colegiados de Circuito, 2017) as the minimum guarantee of this right that would be recognized as an intermediate access according to the World Health Organization guidelines.

4.2.1.2.6 Conclusion

In conclusion, the Human Right to water applicable to Mexico City was analyzed in four different legal sources: Constitution, International Treaties, Federal, Local Laws, and Jurisprudence. The Constitution is the basis of this human right to water, even when it also acknowledges that in its management it should be seen as a resource. The characteristics of what means the guarantee of this right are defined by the international treaties. The federal law establishes that water at a federal level is managed as a resource rather than a right and shows the involved institutions. For this, it describes the faculties and limitations of the institutions and their competencies. At the local level, the water extends the aspects of this right and increases social tools for its legal demand and enforcement. Also, it gives infrastructure faculties to the authorities. Finally, the jurisprudence shows the aspects where there are conflicts for the guarantee of this right. All these sources are complementary to each other.

From these legal sources, the border evaluation criteria will be then the content on Article 4 of the Mexican Constitution, complemented with the content in international treaties and the tools of the faculties of the institutions at the federal and local law level. All of this will be included in the theory of change described below, to have then a clear criterion for the sustainable social foundation of Mexico City's policies.

4.2.1.3 Chosen Criteria of Human Rights Access to Water

From the legal framework described above, it was then found that the border of the social foundation of the system is Article 4 of the Mexican Constitution, complemented with the other legal framework from the international, federal, and local levels. To get to this border, there is the need to follow the theory of change or logic within the complementary legal framework based on Article 4 of the Mexican Constitution in *Table 4-4* below.

Table 4-4 – Theory of Change of the Human Right to Water in Mexico City

	Human Right Use Criteria for Mexico City's Water Policies Sustainable Evaluation
Problem (Cámara de Diputados, 2012; J. F. Cárdenas Gracia, personal communication, April 2, 2021; Committee on Economic, Social and Cultural Rights, 2003, p. 15; H. González Broc, personal communication, April 15, 2021; J. Silva Pastrana, personal communication, April 5, 2021; World Health Organization, 2011)	According to the elements required for the human right to water in Comment 15 of the general assembly, there are the following challenges: - *Water Availability*: The average water consumption is 350 per capita per day in Mexico City, which is much over the international advised optimal use. Also, there is a great range of inequalities regarding water consumption through municipalities. - *Water quality*: There is very polluted water. - *Water Accessibility:* a) Physically there are not enough and good quality public hydrants for all. b) Economically there is a discussion about what the progressive tariffs should be, what the consequence is of not paying the tariff. Moreover, related to this lack of payment is that not all the water consumption is accounted for correctly. Also, that there is an increasing investment need for water management. c) There is discrimination of the water services in quantity, quality, and services in the different municipalities. d) There are increasing water educational campaigns to take care of the water but not to reduce its consumption. Cárdenas added: a) Enforceability of rights. b) Lacking federal law for water right.

Goals (J. F. Cárdenas Gracia, personal communication, April 2, 2021; Committee on Economic, Social and Cultural Rights, 2003; Estados Unidos Mexicanos, 2021)	-Article 4 Paragraph 6 of the CPEUM complemented with the characteristics of water in the General Comment No. 15 of the ICESC. -To complement the goals, Article 9 of Mexico City's Constitution, as well as principles at the federal and local levels that shows the values required to be followed when translating this right into more concrete action. -Include long-term political incentives to create policies to guarantee access to water. -There is the highlight of three issues, but not an agreed perspective about: a) Governance, and b) Tariffs Regulation.
Policy Instruments (Cámara de Diputados, 1992; Gobierno de la CDMX, 2008)	There are precise policy instruments recognized at the federal and local levels: Article 14 Bis 6 of the Law of National Waters: a) Hydrological Planning, b) Concessions and Assignations, c) Management of National Waters, d) Charging of "rights" caused by the exploitation, use, discharge, and protection of water. e) Participation of the society's organizations and users, f) Conflict Resolution Mechanisms, g) Social Supports for marginalized communities, and h) National Information System. Article 21 of the Law for the Access, Disposition, and Sanitation of Water in Mexico City: a) Planning, b) Technical criteria and environmental norms for Mexico City, c) Economic instruments, d) Social Participation, and e) Education, culture promotion and information in the topic of hydrological resources.
Outputs **(Suprema Corte de Justicia de la Nación, 2021)**	The clearer outputs are the precise activities that each of the institutions of the recognized water system for Mexico City's water. Therefore, this criteria includes analyzing whether each of these institutions is complying with all the faculties they have for the policies. The Jurisprudence shows the conflicts today are regarding: non-compliance with tariffs, discrimination, and conflictual water uses.
Effects **(J. F. Cárdenas Gracia, personal communication, April 2, 2021)**	There have been already several cases taken to court that have favored the individuals, as it has been recognized the access to the human right to water, and the obligation of the State to guarantee this right. Therefore, this right has been guaranteed, but not for all. Even when there have been other judicial measures to defend individuals for the guarantee of this right, there is the required of a continuous guarantee of the right and of tools to enforce for it.

Source: Own Creation

This theory of change showed that the law gives normative elements of what should be the social sustainable goal. Also, it shows what are the faculties and activities that the government has, to achieve this goal. Moreover, it shows that the current state of the guarantee of the water right has not yet been achieved, as there are specific topics of demands for it. However, it is positive that there is the existence of demands already, and this can also show the elements of how this right has not yet been achieved. This theory of change will be then the social foundation criteria to evaluate Mexico City's water policies.

4.2.2 Ecological Ceiling Evaluation Criterion - Freshwater resource use ecological boundary

In the Doughnut Economic Model at the planetary level, the environmental ceiling is described as the planetary boundaries. However, this research is mainly focused on the freshwater resource challenge. For this reason, to analyze what would be the environmental ceiling for Mexico City's water system, the freshwater resource boundary at Mexico City's level scale was chosen as the environmental criterion for this evaluation. For this, it was found that there is a calculation called "minimum ecological water flow" at the planetary and local level that could be used for this sustainability criterion purpose. This criterion will be then described below.

4.2.2.1 About Planetary Boundaries

The Planetary Boundaries are a proposal to define a "safe operating space for humanity" (Rockström et al., 2009) based on "the intrinsic biophysical processes that regulate the stability of the Earth System" (Steffen et al., 2015). It is considered an approach to inform efforts toward global sustainability in policies from the environmental perspective. The boundaries serve to provide guidelines for humans: a) to understand the relevant processes that regulate the stability of the Earth System, while b) creating thresholds to limit the human perturbation of these processes (Gleeson et al., 2020).

These boundaries are defined as "human-determined values of the control distance from a dangerous level" (Rockström et al., 2009, p.5). They are a combination between the most updated scientific knowledge and normative assumptions at the global level about this knowledge. Hence, for the scientific aspect, there was an analysis about what was the "range(s) within which Earth System processes varied in the Holocene as a scientific reference point for a desirable planetary state" (Rockström et al., 2009, p.3). They tried to analyze the "most comprehensive, aggregate and measurable parameter for individual boundaries" (Rockström et al., 2009,p.5). Then, from a normative perspective, they used the precautionary principle to choose the boundary amongst these ranges. For this reason, they have the lowest number among these ranges as the boundary. The nine planetary boundaries created by Rockström et al (2009) and updated by Steffen et al. (2015), are the ones shown in *Figure 4-3*.

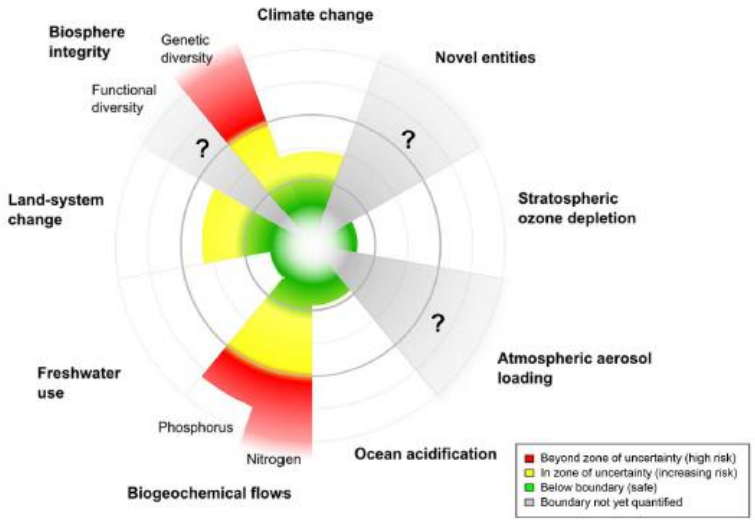

Figure 4-3 – Nine Planetary Boundaries
Source: Steffen et al., 2015a

These boundaries serve as "first estimates (…) surrounded by large uncertainties and knowledge gaps" (Rockström et al., 2009, p.2). Thus, there are only initial assumptions for the boundaries that still include uncertainties that can be further worked upon. For this reason, these boundaries serve as general guidelines of what are the environmental challenges that should be globally prioritized, but their measurements should not be restricted to the calculations made according to the Steffen et al. (2015) Supplementary Material.

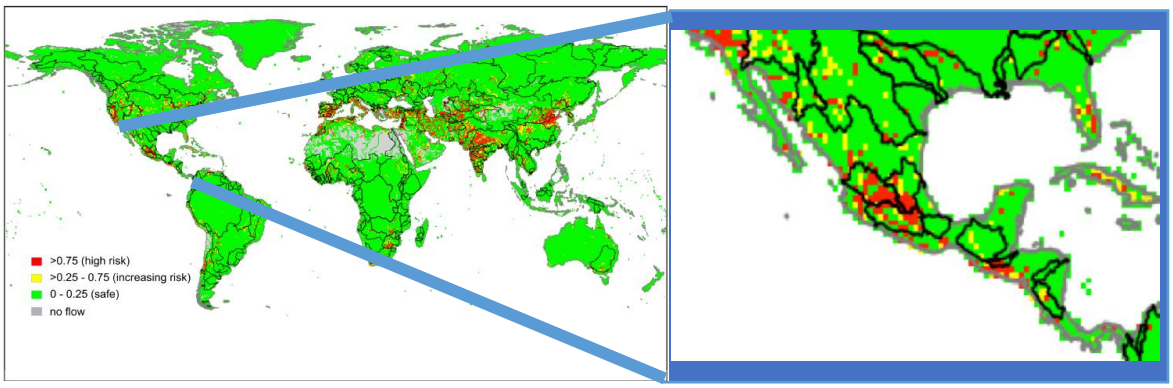

Figure 4-4 - Global Freshwater Resource Use boundaries – Mexico Focus
Source: Zoomed picture of the maps done by Steffen et al. (2015b) concerning the "transgression of the allowed monthly water withdrawals defined by EWF, plotted as the degree of exceedance (fraction of maximum allowed level) during months that show such an exceedance).

For example, one of the boundaries which seems to have a low risk is the "Freshwater Use Boundary". However, as seen in the zoom shown in *Figure 4-4* (Steffen et al., 2015), there is a higher risk in Mexico City for this resource. Therefore, after acknowledging the existence of a freshwater use boundary, there is the need to calculate what the risk is of crossing the planetary boundary in this location, and how this can be prevented.

For this reason, the understanding of what this freshwater use planetary boundary is at the local level will be used as the second criteria of sustainability transitions. It will be the ecological criteria to evaluate Mexico City's water policies sustainability transitions.

4.2.2.2 Freshwater Use Planetary Boundary

The Freshwater Use Planetary boundary is mainly based on the concept of "environmental water flows" (Steffen et al., 2015). An environmental flow model is defined as the flows that "describe the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being" (Arthington et al., 2018). Following the definition, Steffen (2015b) also states that these models generally include the variables of: a) Quantity, b) Quality, c) Timing, d) Duration, and f) Frequency.

Due to the complexities of measuring all these elements on a global scale, Steffen decided to use a proxy. Hence, he decided that the calculation of the environmental water flow of the planetary boundary would be measured by: "the minimum amount of blue water that must remain within a river basin (as an average % of mean monthly flow) to sustain ecosystem processes and resilience of inland and coastal landscapes." (Steffen et al., 2015b, p.9) What this variable was trying to analyze is whether the withdrawal of water from a river basin was recovered monthly.

From this general environmental water flow concept, Steffen et al. (2015b) created then two main control variables for the planetary boundaries at the global and the river basin level:

- *Global Control Variable*: Consists in the maximum amount of consumptive blue water use (km^3/yr).
- *River Basin Control Variable*: Consists in the maximum allowed amount of blue water withdrawal from a river basin defined as the average % of the mean monthly flow.

There have been critiques that state that these calculations do not reflect the environmental challenges of water use, and of water in general (Bunsen et al., 2021; Gerten et al., 2013; Gleeson et al., 2020). Also, this is strengthened by Steffen et al. (2015b) statement itself when the paper acknowledges the existence of other environmental water flow models.

The reason for the critique is that the current planetary boundary is only using blue freshwater in river basins as a proxy for the entire water cycle. Moreover, the critiques state that the way that Steffen et al. (2015a) calculate this planetary boundary should only be used if the methods "are not successful" for a more comprehensive approach or if "simplicity of communication is surmount" (Gleeson et al., 2020). Otherwise, there is the need to observe other elements from the hydrological cycle that should also be taken into consideration for this freshwater use ecological boundary.

For this reason, *Gleeson et al.* (2020) propose the following elements of the hydrological cycle, shown in *Figure 4-5,* as part of a new ecological planetary boundary: a) ground water; b) soil moisture; c) atmospheric water; d) frozen water, e) surface water.

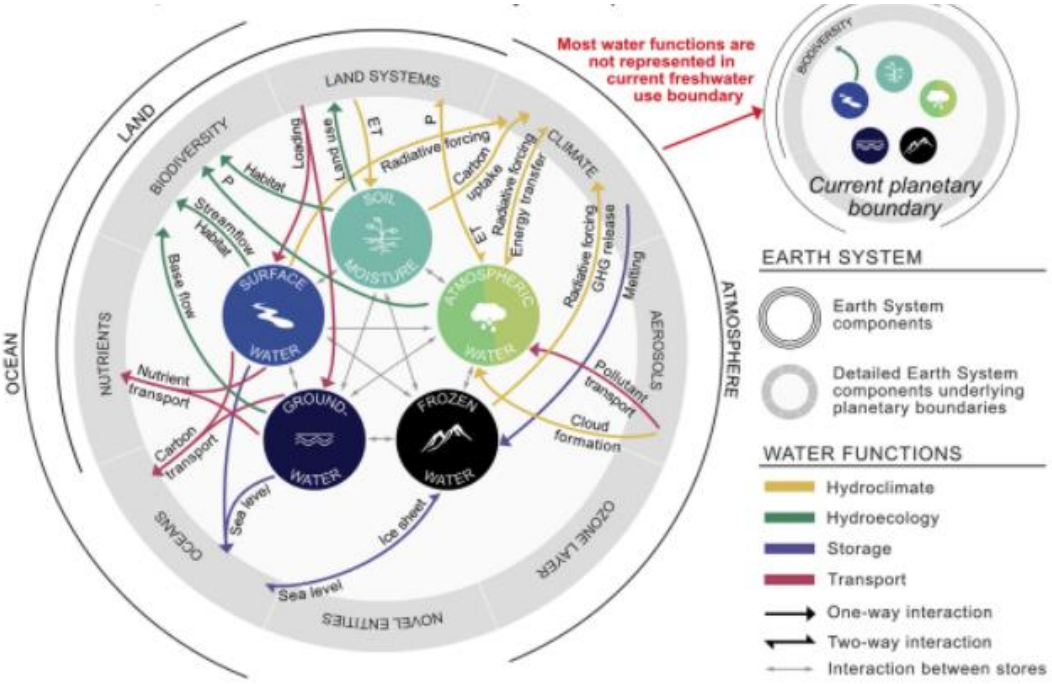

Figure 4-5 – Water Stores, functions, and interactions with Earth System Components (Water Planetary Boundary Proposed Components).
Source: Adapted from Gleeson et al. 2020.

Hence, these five elements proposed by *Gleeson et al. (2020)* can be used as part of the environmental flow models to have a more comprehensive understanding of the freshwater ecological boundary. It was then analyzed whether there existed water flow models in Mexico City that included these five elements proposed by *Gleeson et al. (2020).*

4.2.2.3 Mexico City's Freshwater Ecological Boundary – From Planetary to Urban Boundary

The Planetary boundaries were measured at a global scale. However, to understand what is the criteria that policies would have to follow for Mexico City, this boundary must be measured at the urban scale. Following the criterion of Steffen et al (2015a) as well as the critiques that intend to increase the usefulness of the freshwater use ecological boundary, there was the analysis of what would be then the freshwater use ecological boundary for Mexico City. For this, it was found that there exists a concept in Mexico's Law and Policy called "minimum ecological water flow" ("caudal mínimo ecológico" in Spanish). This minimum ecological water flow aligns with the general requirement of the calculation of "environmental water flows" of the planetary boundary criterion. This indicator does not consider a more complete water cycle indicator. However, due to its comparability at the planetary level and as an official indicator, the minimum ecological water flow indicator is the basis taken as the ecological boundary criterion for this research. This criterion was then used in this research to transform the ecological planetary boundary criterion into an urban one.

4.2.2.3.1 Ecological Water Flow

The "minimum ecological water flow" idea emerged internationally from various treaties including the Brisbane Declaration (International River Foundation, 2007), recently updated in 2017. Later, Mexico incorporated it into its policy and legal institutions. Now, the National Water Law of Mexico describes the characteristics of the minimum ecological water flow in Article 3, paragraph LIV, by describing it through the definition of "environmental use of water" (Deputees Chamber, 1992, Article 29 bis 5 and 3 fraction LIV), as the:

> *"Environmental Use" or "Ecological Conservation use": The flow or minimum volume required in the receiving water bodies, including currents and reservoirs of a different kind, or the minimum flow of natural discharge of an aquifer, that must be conserved to protect the environmental conditions and the ecological balance of the system".*

The method of how to calculate this ecological water flow was also regulated in the standardized Mexican norm "NMX-AA-159-SCFI-2012". This regulation states the methodology that must be followed in each of the basins. It includes the analysis of the "superficial and groundwater flows" where there is sufficient data, and the formula of the minimum ecological flow (Ministry of Economy, 2012,p.61).

As a result of this ecological water flow concept and regulation, CONAGUA and WWF analyzed the ecological water flow of the different river basins in Mexico. The results showed that there was a very high ecological importance while a very high water pressure in Mexico City's Panuco Basin (CONAGUA & WWF- Fundación Gonzalo Río Arronte, 2012).

However, the "minimum ecological water flow" is not a measurement that is obliged by the law to be published publicly (Deputees Chamber, 1992, Article 22, Paragraph 8), only the *availability of water indicator* is. The author has not been able to access official data of what is the minimum ecological water flow official measurements for Mexico City's basins' superficial and groundwater flows. Thus, the only information obtained about the minimum ecological water

flow, comes from a map made in collaboration of CONAGUA with the WWF (CONAGUA & WWF- Fundación Gonzalo Río Arronte, 2012). Thus, this *availability of water indicator* was then used as a proxy for the main ecological bound criterion indicator for this evaluation, related to the minimum ecological water flow. Also, it is an official measurement that the national government is obliged by law to calculate and then publish in the Official Journal of the Federation ("Diario Oficial de la Federación"). This measurement can be done for the superficial water as well as for the groundwater. It is measured in each of the hydrological sub-basins of Mexico, by the CONAGUA (Deputees Chamber, 1992, Article 22 Paragraph 8). For this reason, it also responds to the requirements previously mentioned to pass from a planetary to an urban boundary, with a holistic water perspective.

The two measurements for freshwater availability are the following:

- **Average Annual Superficial Freshwater Availability**: "In a hydrological basin, it is the value that results from the difference between the annual average volume of the runoff of a downstream basin and the committed average annual volume".

- **Average Annual Groundwater Availability**: "It is the average annual volume of groundwater that can be extracted of that hydrogeological unit for diverse uses, in addition to the already licensed extraction and the natural committed discharge, without endangering the equilibrium of ecosystems".

To understand how this indicator of **"available water"** works as an urban boundary, Mexico City's water management system will be described below and the measurement of Mexico City's availability of water sub-basins will be given.

4.2.2.3.2 Mexico City Water Management System

Mexico City has a water management system that collects water from its hydrological basin, as well as imports water from other basins as there is not enough supply for the water consumption required in the city. Taking this into consideration, there are 8 general steps of Mexico City's water system, that consider from the moment where the water is captured, the infrastructure required to give water access, and the actions required to *return* the water to the ecosystem (SACMEX, 2021). The 8 steps are: 1) Catchment, 2) Purification, 3) Storage and Distribution, 4) Use, 5) Sewage and Drainage, 6) Treatment, 7) Reuse, and 8) Environmental Return.

Even when we are describing Mexico City's water system, these steps cannot be only observed from a local point of view. The reason is that Mexico City's water boundaries cannot be delimited within Mexico City's political boundaries, as the water has its biological borders. Also, because it has systems to import water from other basins, as it does with the Cutzamala system – one of the largest potable water systems in the world (Anonymous, n.d.). For this reason, Mexico City's water system is embedded in a national management process that divides the water basins by regions rather than by states.

As a result, Mexico City's water system is governed by one of the thirteen "Hydrological/Administrative Regions" established by CONAGUA (Deputees Chamber, 1992, Article 3 Paragraph XVI - b). These regions are divided in this way because they grouped one or several groups of "hydrological basins" (Deputees Chamber, 1992, Article 3 Paragraph XVI; Ministry of the Environment, 2015) for their management. Mexico City is in Region Number XIII (SEMARNAT, 2015), which also includes the States of "Hidalgo" and the "State of Mexico" (SEMARNAT & CONAGUA, 2013).

To manage these hydrological/administrative regions, CONAGUA has also acknowledged the overlapping existence of 37 other regional "Hydrological Regions". In comparison with the administrative units mentioned above, these hydrological units describe "the natural limits of the great Mexican basins, they are areas created in the function of their morphology, orography, and hydrology" (CONAGUA, 2021; Deputees Chamber, 1992, Article 3 Paragraph XVI -a). Mexico City's water system is part of two of the 37 hydrological regions of Mexico: Panuco Hydrological Region Number 26, and Lerma-Santiago Hydrological Region Number 12 as observed in *Figure 4-6*.

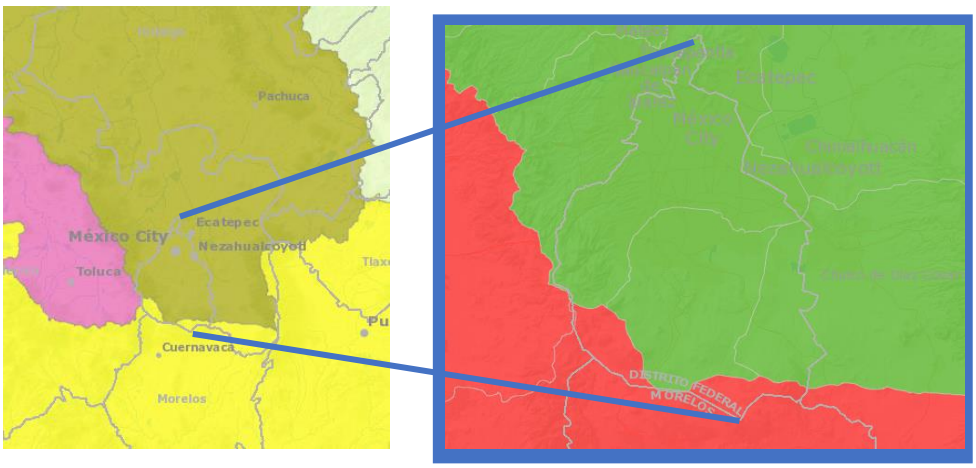

Figure 4-6 – Mexico City Hydrological Basins
Source: CONAGUA, 2021; National System of Water Information, n.d.

From Mexico City's hydrological basins, seen in *Figure 11,* Mexico City is part of four sub-basins. The name of the sub-basins and the measurement of the "availability of water" indicator given for each sub-basins by CONAGUA's national decree will be stated below:

- Panuco Hydrological Sub-basins:
    - Xochimilco (2665). The availability of water is 0.083 hm^3.
    - Río La Compañía (2666). The availability of water is 0.09 hm^3.
    - Ciudad de México (2670). The availability of water is 1.262 hm^3.
- Lerma-Santiago Sub-basins:
    - Río Amacuzac (1802). There is negative availability of water. The amount is -239.77 hm^3 of water required to fulfill the committed annual use.

The water availability data in Mexico City show that there is no available water in Mexico City, as shown in *Table 4-5* below:

Table 4-5 - Availability of Water grouped by State and Hydrological/ Administrative Basin (Millions of Annual Cubic Meters)

Hydro Logical / Adminis-trative Region	*State*	*Aquifer*	*Annual total Average Recharge*	*Extraction Volume of Groundwater*		*Annual Average Availability of Water*	
				VCAS	VAPTYR	POSITIVE (+)	NEGA-TIVE (DEFICIT)
XIII. Water of Mexico's Valley (Aguas del Valle de México)	Mexico City	Metro-politan Zone of Mexico City	512.8	1,019.89	0.133	0	-507.23

Source: Adapted from (CONAGUA, 2020)
(VCAS= Licensed Volume of Groundwater, , VAPTYR= Extraction volume still pending of title or register in the REPDA)

This table shows the clear deficit of water availability in Mexico City. This data is sometimes also interpreted by including the water imports calculations. Thus, the availability interpretation would change. However, if we consider the hydrological basin only on itself, there is no water availability and there is high water pressure.

4.2.2.4 Chosen Criterion of Freshwater Resource Use Ecological Boundary

As shown above, to choose a freshwater resource use's ecological boundary for Mexico City, it is needed to link the water system and the water cycle of Mexico City. The concrete criteria for the boundary can then be calculated as: total annual average recharge minus the committed water. For this, the indicator of "availability of water" gives us the limit of the resource that could be used currently. However, this boundary is not enough to evaluate sustainably the theory of change of Mexico City's water policies. For this, there are other elements in the theory of change that tell us the requirements of the policies to transit to sustainability.

Hence, a criterion to evaluate the policies from an ecological boundary perspective can be based then on a theory of change that tries to make a link of the water system to the hydrological cycle of the basins related water basins of Mexico City and considers the water availability indicator. The elements for this theory of change observed from the data are the ones in *Table 4-6* below

Table 4-6 - Theory of Change to set an ecological boundary for Mexico City's policies

Theory of Change Elements	**Ecological boundaries for Mexico City's Policies**
Problem (J. Silva Pastrana, personal communication, April 5, 2021)	*Ecological: a)* Scarcity of resources, b) Inefficient use of the resource, c) Overexploitation of the Resource, and d) Reduced rainwater infiltration due to gray concrete pavements. *Economic:* Required imports of water from other basins. *Infrastructure:* Water quality, including water pollution and lack of water treatment, Water system leakages. *Informative:* Lack of clear public data about the water, and b) No data transparency.

	-Other environmental risk-related issues including: floods, earthquakes, climate change, and biodiversity
Goal (Government Ministry, 2021; J. Silva Pastrana, personal communication, April 5, 2021)	.-Guarantee a minimum ecological water flow for Mexico City's basins and the ones it gets water from, for today and for the future. -Give long-term continuity to the proposals.
Policy Instruments (Gleeson et al., 2020; J. Silva Pastrana, personal communication, April 5, 2021)	*Administrative:* -Increase governance cooperation (with other level governmental agents as well as other private agents), -Management cooperation for water agents, - Stricter regulations - Enforce environmental sanctions, -Capacity*:* Improve institutional and technical capacities. -Hydrological Balance -Participation Forums. -Measure the non-accounted water. -Nature-based solutions. *Economic:* -Increase the efficiency of the public budget in projects and the investments used. *Informative:* - Ecological Education - Data gathering of the flows in different locations. -Adapt models. -Culture of *taking care* of the water. -Stakeholder involvement through all the stages. *Technological:* -Application of new technologies. - Rain-water catchment projects. -Include models not only with the environmental water flow but also with the hydrological cycle parts of: a) ground water; b) soil moisture; c) atmospheric water; d) frozen water, e) surface water.
Outputs (CONAGUA, 2020; Gleeson et al., 2020)	There exists the availability of water publication of Mexico City's basins, and of the basins where Mexico City imports its water from. The current water availability is in deficit by 507 million annual cubic meters. Use of the hydrological cycle model to make a wider understanding of the basin.
Effects(J. Silva Pastrana, personal communication, April 5, 2021)	Ecological Security of the two hydrological basins where Mexico City is located, as well as from the ones that it imports water from. Integral Management of the Water.

Source: Own creation.

For this reason, this theory of change is based on the required water cycle and water system elements of Mexico City's water to at least secure the minimum ecological water flow of the hydrological basins of Mexico City and of the basins where it imports its water from, by using the water availability indicator data. This theory of change is the ecological ceiling criteria to evaluate the current water policies of Mexico City.

4.3 Evaluation of Mexico City's Governmental Water Policies.

This evaluation analyzed whether the policies are transiting the current Mexico City's water system from the *BAU* borders of the system into sustainable borders (that would allow a safe and just water system in Mexico City). To evaluate this, the two previous criteria for what a sustainability scenario would mean were identified in this Chapter:

- **Social Foundation**: The theory of change to guarantee Mexico City's Human Right to Water regulated by Article 4 of the Mexican Constitution and complemented with jurisprudences and other international, federal, and local regulations.

- **Ecological Foundation**: The theory of change to get to a Minimum Ecological Flow, that is included as part of the water availability calculation published in the Official Federation Journal. This calculation is complemented by the relevant scientific water cycle and water system data of the aquifers of the city, and of the aquifers from the basins of the aquifer from where Mexico City imports large quantities of water.

With these two criteria, there were two steps done as part of this evaluation:

- **Comparative Evaluation Step** that compares the theories of change of the policies and from the sustainability transition scenario from the information in Table 3, Table 6, and Table 8. It compares the elements of the theory of change of: problems, goals, policy instruments, outputs, and effects.

- Analysis of the degree of **Mexico City's Water Sustainable Transitions**. For this, it will interpret the similarities and differences of these tables and conclude then about: a) ongoing transitions, b) missing transitions, and c) threats to transitions.

4.3.1 Policy's Problems Comparison

The *policy's problems* described how the policies and the socio-ecological sustainability model defined Mexico City's water issues or challenges, shown in *Table 4-7*.

Table 4-7- Problems Sustainable Evaluation of Mexico City's Water Policies

	Status Quo	**Socio-Ecological Sustainability Model**	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect - Limit of Freshwater Resource Use**
	There are problems in the following issues: -*Social*: Lack of water consumption for all, and trust. -*Ecological*: Aquifer overexploitation and pollution.	There are problems with guaranteeing the water availability, quality, and accessibility of the resource. They include: *Social* there is an inequal distribution of the services and the water. -*Ecological* over-consumption of the resource, and pollution.	There is a deficit of water availability of the aquifer. There are also increasing risks that include: -*Ecological:* Decreasing groundwater reserves of own basin and from other basins, aquifer pollution, lack of water infiltration.

Problems (Table 4-1, Table 4-4, and Table 4-6)	-*Perspectives* related: Short-term view. -*Infrastructural/ Technological*: Lack of maintenance of infrastructure, treatment, investments, and professional capacity.	- *Perspective:* Water is seen politically in the short- term. -*Infrastructurally*: There is a lack of water hydrants. -*Economically* there is a lack of solutions of how to get investments, while also letting assuring non-discriminatory access to water even when tariffs are not paid. - *Legally*, enforcement of water rights is needed, and creating the federal law regulating Article 4 Paragraph 6 of the Mexican Constitution.	-*Infrastructural:* Water system pipe leakages, floods, and city plunging. -*Economical:* Water loss through sewage, lack of water treatment. *Informative:* Lack of data transparency.

Source: Own creation.

From this *Table 4-8*, it is interpreted in *Figure 4-7,* what is the degree in which policies are including the problems from the socio-ecological sustainability model:

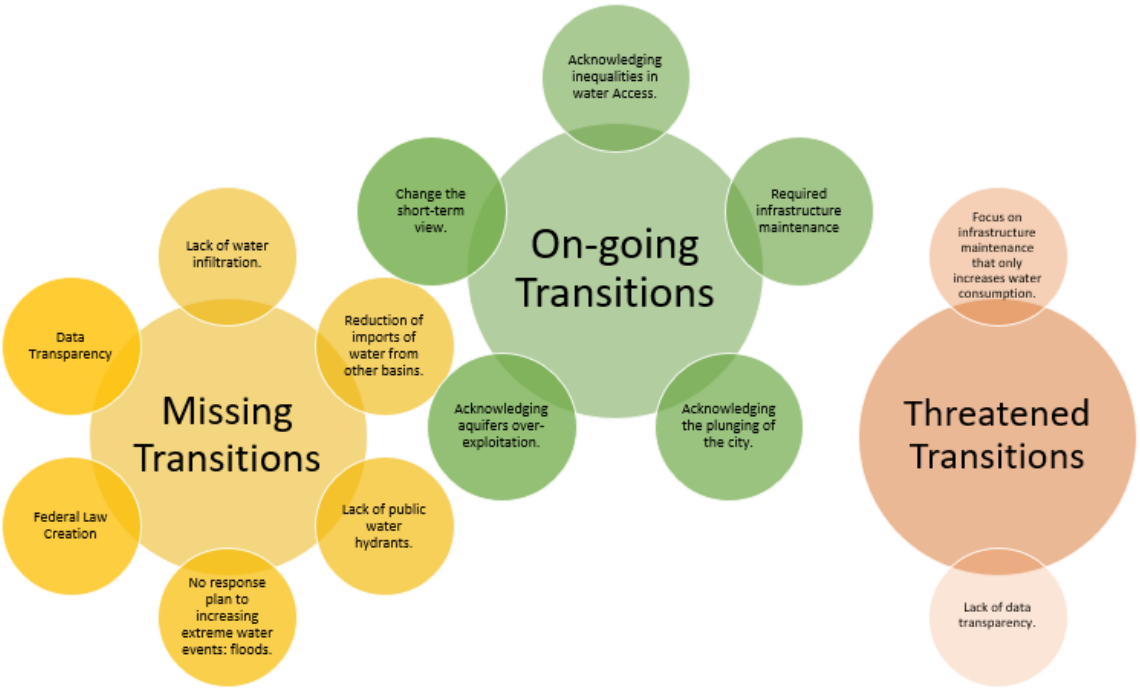

Figure 4-7 –Policy's Problems for Sustainable Transitions
Source: Own creation.

4.3.2 Policy's Goals Comparison

The comparison between the goals shows whether the current policies and the socio-ecological sustainability are leading in the same direction in *Table 4-8*.

Table 4-8 Goals Sustainable Evaluation of Mexico City's Water Policies

	Status Quo	Socio-Ecological Sustainability Model	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect -Limit of Freshwater Resource Use**
Goals (Table 4-1, Table 4-4, and Table 4-6)	SEDEMA and SACMEX have different but aligned policy goals: a)SEDEMA's goals: a) Rescue of Rivers and Water Bodies and b) Sustainable Management of Water b)SACMEX' goals: a)Guarantee sufficient but non-continuous water supply for everyone., b) Reduce the water supply in 2m³/s. Other more specific goals: a) Increase water treatment use, b)Self-sufficiency of water supply, c) Long-term political will, d)Work coordinately with other sectors, and e) Reduce climate change hydrological risks.	Article 4 paragraph 6 of the Mexican Constitution: *Every person has the right to* ***access, disposition, and sanitation*** *of water for* ***personal and domestic consumption*** *in* ***sufficient, salubrious, acceptable, and accessible.*** *Baseline*: There are 9.2 million people in Mexico City, with a growing population. There is an acknowledgment of the relevance of the issue, but discussions about: Governance, Tariffs.	Maintain the stability of the ecosystem. The baseline measure are the general characteristics of this ecosystem in the Anthropocene. *Baseline*: There is no published calculation about the minimum environmental water flow. The availability of water includes this calculation. From the availability of water indicators, the annual total recharge is 512.8 million annual cubic meters. The licensed volume of water is 1,019.8973. Mexico City's official indicator is the "minimum ecological water flow". It can be from Pánuco's hydrological basin, or other basins where Mexico City imports water from.

Source: Own creation.

From this table, it is interpreted in *Figure 4-8,* what is the degree to which policies are including the goals from the socio-ecological sustainability model:

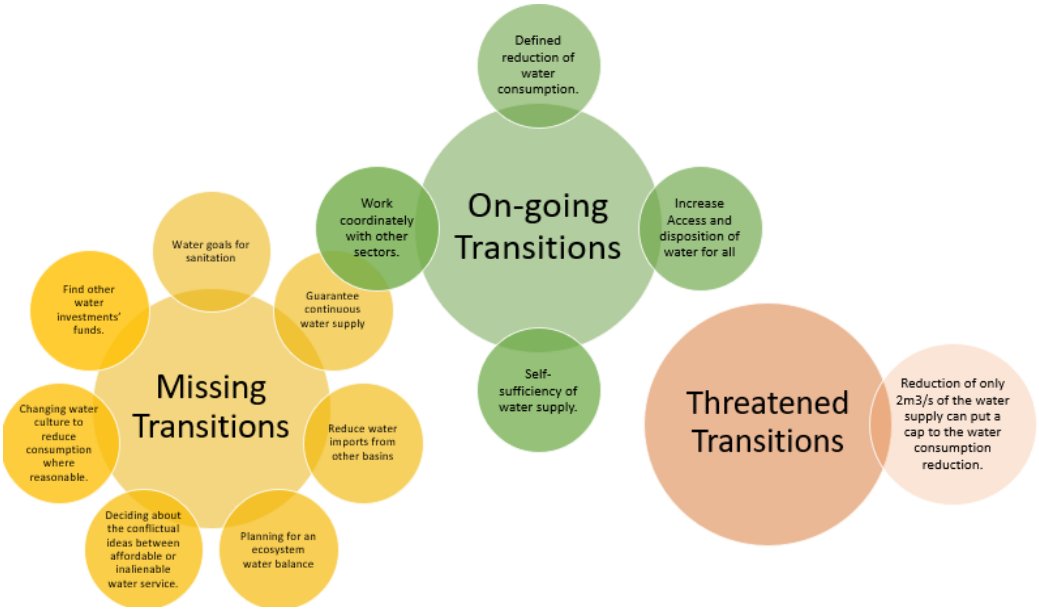

Figure 4-8 Policy's Goals for Sustainable Transitions.
Source: Own creation.

4.3.3 Policy's Instruments Comparison

In the following tables, the **sustainable evaluation** of the **policy instruments** will be described. It will be divided by types of policy instruments: administrative, economic, informative, and technological/infrastructural in *Tables 4-9, 4-10, 4-11, 4-12* respectively.

4.3.3.1 Administrative Policy Instruments

Administrative Policy Instruments are the ones related to the public administration logistics, general plans, and agents. Hence, *Table 4-9* shows what are the already existing instruments that can help to make a transition.

Table 4-9 – Policy Instruments Sustainable Evaluation

	Status Quo	**Socio-Ecological Sustainability Model**	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect - Limit of Freshwater Resource Use**
Policy Instruments Table 4-1, Table 4-4, and Table 4-6)	**Administrative.-** *Management:* -Reordering of water uses. -Creating sectors for water distribution. *Institutions:* Limiting the faculties of the different institutions of water. -Creation of measurements of these sector water flow. *Law:* Debate over new Climate Change laws, and goals in the laws *Participative Processes* for the planning. *Indicators* – There will be indicators in the PGIRH. However, it is not yet published. *Plans:* Master Plans: – Programs with particular focus on: drainage, water	**Administrative**.- *Management*: Water is considered a natural resource rather than a right. *Institutions*: Creation and maintenance of local, regional basin, and national institutions for water management. These authorities have specific faculties and obligations. *Law*: Conflict resolution mechanisms, internal law adequation. *Partnerships* with other public institutions, as well as private agencies and individuals. *National Standards*: There are national standards that serve as technical criteria, mainly Norm(SE, 2012) *Preventive Planning Programs* including infrastructure plans. (CDMX Consti)	**Administrative.-** *Management:* Water is considered an illimited resource. There are 8 steps of the water system in Mexico City. (SACMEX, 2021) *Institutions:* Mexico City is part of the XIII Administrative/Hydrological Region from CONAGUA. Mexico City is part of the Pánuco and Lerma-Santiago Hydrological Basins. *Professional Capacity:* Developing professional capacity, mainly of the new generations in the water sector. *Partnerships:* Developing the professional capacity of the new generations in the water sector. *Indicators* should be created and monitored. Some of the indicators that can be used are: water stress, water depletion, water scarcity, water footprints, water wedges, water-use regimes, human appropriation of evapotranspiration, peak water, renewable water resources, water-

	treatment, reuse, and geographically focused. -Hydrological Integrated Resources General Program.	-*Property*: Water as a public good, while concessions and assignations can be given to private agents and individuals.	related UN SDGs, and hydroclimatic separation (Gleeson et al., 2020).

Source: Own creation.

From the table, we can observe that the administrative policy instruments' elements that show an ongoing **sustainable transition** are: a) Creating sectors for improving the distribution of water to everyone as a right, b) Reordering the water uses to decrease the use of water, and c) Creating programs and management plans. However, there are some plans that even when made, have not yet been fully accepted and so published (H. González Broc, personal communication, April 15, 2021).

In comparison, we can observe that the administrative policy instruments' elements for a sustainable transition that are **missing** are:

a) Developing professional capacity, mainly of the new generations in the water sector.
b) Using indicators based on the Mexican national standards.
c) Creating participative processes that also include debates with companies to reduce the consumption of water and to increase the investments in water solutions.
d) There is geographical analysis but not analysis of the water supply chain to know what part of the chain requires to be fixed. There is mainly one general solution: telemetrics for all the supply change. The results suggest that this has stopped the analysis also of solutions on other parts of the supply chain such as in the environmental return, decreasing the creation of solutions to infiltrate the water back to the groundwater.
e) Participative processes are done through the planning policy phase, but not during the implementation phase. Thus, there is a gap there to fill that can also build trust and make it easier for the changes required in the water system.

Finally, the administrative policy elements' that may **threaten** a sustainable transition are to limit the faculties of each of the local water responsible institutions, rather than trying to complement and collaborate to solve problems, and even to collaborate with the regional, and national institutions and authorities.

4.3.3.2 Economic Policy Instruments

Economic Policy Instruments are considered the monetary actions available to obtain investments or resources. Hence, *Table 4-10* will compare the current status quo economic policy instruments of Mexico City's water policies with the socio-ecological sustainability model.

Table 4-10 – Economic Policy Instruments Sustainable Evaluation

	Status Quo	Socio-Ecological Sustainability Model	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect - Limit of Freshwater Resource Use**
Policy Instruments (Table 4-1, Table 4-4, and Table 4-6)	**Economic.-** **-**Public Budget Investments increases. -Increase private investments. -Reduction of groundwater exploitation. -Repair and maintenance of water system.	**Economic.-** -Public budget -Concessions and assignations limits depending on the water availability. -Differentiated Tariffs -Limit the consumption of resources. -Reduce water waste. -Distribution of facilities and services. -Adopt program for vulnerable or marginalized communities. **-**Use low-cost techniques and policies. -Response mechanisms for emergencies.	**Economic.-** -Measurement of the ecosystem services of the water in the region. -Water reuse.

Source: Own Creation.

From the table, we can observe that the economic policy instruments' elements that show an ongoing **sustainable transition** are: a) Public budget use, even increase of the budget from previous years, b) Use of concessions and assignations of water, and c) Reduction of water exploitation by decreasing the number of wells to be used for groundwater.

In comparison, we can observe that the economic policy instruments' elements for a sustainable transition that are **missing** in the policies are:

a) They have not spoken of other differentiated tariffs. This may be because they do not know still the measurements of how water is used in the different parts of Mexico City. This data would then suggest this policy instrument could be then a second step.
b) Measurement of the ecosystem services of water in the region.
c) The concessions and assignations are now trespassing the water availability of the region. Therefore, this should be changed.
d) No plan for the distribution of facilities and services. Hence, the results suggest it could also be a second step after the measurements are done.
e) Reduction of water consumption, including water waste.
f) Use low-cost techniques.
g) Create emergency response mechanisms.

Finally, the economic policy elements' that may **threaten** a sustainable transition are if the main focus is on repairing the water system, but not the water hydrological cycle. Thus, policies would not link the cause of affecting the aquifers to the reduction of the water quantity and quality.

4.3.3.3 Informative Policy Instruments

Informative Policy Instruments concern "the collections and provision of information, and are used with the assumption that people behave differently when they have better information and understanding" (Tojo, 2004, p.42). Hence, *Table 4-11* will compare the current status quo informative policy instruments of Mexico City's water policies with the socio-ecological sustainability model.

Table 4-11 - Informative Policy Instruments Sustainable Evaluation

	Status Quo	**Socio-Ecological Sustainability Model**	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect - Limit of Freshwater Resource Use**
Policy Instruments (Table 4-1, Table 4-4, and Table 4-6)	**Informative:** -Macro-measurement, and telemetrics. -Cultural education.	**Informative.-** a) National and Local Information Systems, b) Education and culture promotion resources.	**Informative.- a)** Declaration of the availability of water, that includes calculations of quantities of water, but not of the quality. b) There are Geographical Information Systems studies, social science, natural science, and ecological models. **c)** Some of the models are being worked on in collaboration with the authorities.

Source: Own creation.

From the table, we can observe that the informative policy instruments' elements that show an ongoing **sustainable transition** are: a) Macro-measurement and telemetrics, b) Cultural Education where there are even campaigns to inform the public, and c) Academic-based models in the master plans. In comparison, we can observe that the informative policy instruments' elements for a sustainable transition that are **missing** are: a) Improving the transparency of the measurements and the declaration of the availability of water, b) Improving the information given by the different organisms, and c) There is the information for water, but it is not very easily accessible. Finally, there are no elements that **threaten** a policy sustainable transition.

4.3.3.4 Infrastructure/Technological Policy Instruments

Infrastructure/Technological Policy Instruments are the constructions and engineering innovation interventions of the State. Hence, *Table 4-12* will compare the current status quo of the policy instruments of Mexico City's water policies with the ones from the socio-ecological sustainability model.

Table 4-12 – Infrastructure/Technological Policy Instruments Sustainable Evaluation

	Status Quo	Socio-Ecological Sustainability Model	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect -Limit of Freshwater Resource Use**
Policy Instruments (Table 4-1, Table 4-4, and Table 4-6)	**Infrastructure/ Technological.-** -Restoration Projects **-**Treatment Plants. -Leakages reduction -Alternatives of Water Supply	**Infrastructure/ Technological.-** -Use of favorable materials for water catchment in construction and rehabilitation of public spaces including pavements. -Rainwater catchment. -Leakage reduction by the maintenance of infrastructure. **-**Improve water drainage, sewage, and treatment - Development of deep drainage knowledge. -Public Spaces access to water.	**Infrastructure/ Technological.-** **-**Groundwater return. **-**Use of infiltration materials. **-**Water Treatment Plants. **-**Dams. **-**Technological Development for the Deep Drainage. **-**Separating the clean water with the sewage.

Source: Own Creation.

From the table, we can observe that the technological/infrastructure policy instruments' elements that show an ongoing **sustainable transition** are: a) Restoration projects, b) Treatments Plans, c) Reduction of leakages, and d) Creating alternative projects for water supply. They have started pilot projects for rainwater catchment.

In comparison, we can observe that the technological/infrastructure policy instruments' elements for a sustainable transition that are **missing** are:

a) Increasing the number of alternative projects for water supply that includes rainwater catchment.
b) Improvement of water drainage, and sewage.
c) Development of deep-drainage knowledge.
d) Creating public spaces for water access.
e) Separate the clean water from the sewage water.
f) Use of water infiltration materials.
g) Creating groundwater return areas.
h) Creation of dams.

Finally, the technological/infrastructure policy element that **threatens** a sustainable transition is if policies only focus on reducing leakages rather than returning water to the ecosystem. There do not seem to be clear solutions that intend to be regenerative for the water cycle.

4.3.3.5 Policy Instruments Evaluation Summary

The policy instruments are one of the elements of the theory of change where there is more room for change. There are different activities made by different agents that are already transiting towards sustainability and many other elements of Mexico City's water system that are not missing or that threaten a non-sustainable transition. This summary aims to show what

mechanisms have already been used, which ones are missing, and which ones threaten the sustainable transition in *Tables 4-13, 4-14, and 4-15* below. The policy instruments' elements that show an ongoing **sustainable transition** are shown in *Table 4-13*:

Table 4-13 - Ongoing Sustainable Transitions in Mexico City's water Policy Instruments (Table 4-1, Table 4-4, and Table 4-6))

Administrative	Economic	Informative	Technological/ Infrastructure
-Creating water sectors as a management unit. -Reordering water uses. -Creating programs and management plans.	-Use of public budget. -Use of concessions and assignations. -Reduction of water exploitation by decreasing the number of wells being used.	-Doing macro-measurement and telemetrics. -Educating for water culture. -Creating academic-based models within the master plans.	-Restoring rivers. -Increasing water treatment. -Reducing water leakages. -Creating alternative projects for water supply.

Source: Own creation.

This table shows that the main way in which the current **policies are transitioning** towards sustainability is by creating management programs that try to measure the current water flows and reorder them by changing the clean water use to treated water. It is mainly trying to use the water that is already within the system, and it is starting to create some alternative projects including the rainwater pilot plan, as well as education campaigns.

In comparison, we can observe that the policy instruments' elements for a sustainable transition that are **missing** are shown in *Table 4-14*:

Table 4-14 – Missing Sustainable Transitions in Mexico City's water Policy Instruments

Administrative	Economic	Informative	Technological/ Infrastructure
-Differentiated Tariffs. -Redistribution of facilities and services. -Reduction of water consumption. -Using low-cost techniques. -Creating emergency response mechanisms. -Participative processes in the implementation phase.	-Professional capacity development. -Supply chain analysis. -Indicator's creation and use based on Mexican National Standards. -Increasing private investments.	-Transparency of information. -Increase access to information. -Water ecosystem measurement.	-Alternative sources, water drainage, sewage projects. Groundwater infiltration materials. -Creation of dams. -Development of deep drainage. -Creation of dams. -Create groundwater return areas.

Source: Own creation.

These show how there are mainly four elements missing: a) increasing the cooperation between the public and private institutions that are not only water but also risk authorities and individuals that can implement projects, b) reduction of water consumption, c) transparency in the information and d) the development of capacity that faces the problem's characteristics of the system: deep drainage, limited dam capacity, lack of groundwater return. Finally, the policy elements' that **threaten** a sustainable transition are shown in *Table 4-15:*

Table 4-15 – Policy Instruments Threatening Sustainable Transitions
(Table 4-1, Table 4-4, and Table 4-6))

Administrative	Economic	Informative	Technological/Infrastructure
Restrict the faculties of each institution, instead of working cooperatively to solve problems through sectors and time.	Focus on the repair of the system, but not repair of the hydrological cycle water quality and quantity.	None.	Focusing on grey rather than green solutions, even when the goals intend to create nature-based solutions.

Source: Own creation.

In summary, the sustainable transition's degree of the policy's instruments is shown in *Figure 4-9* below:

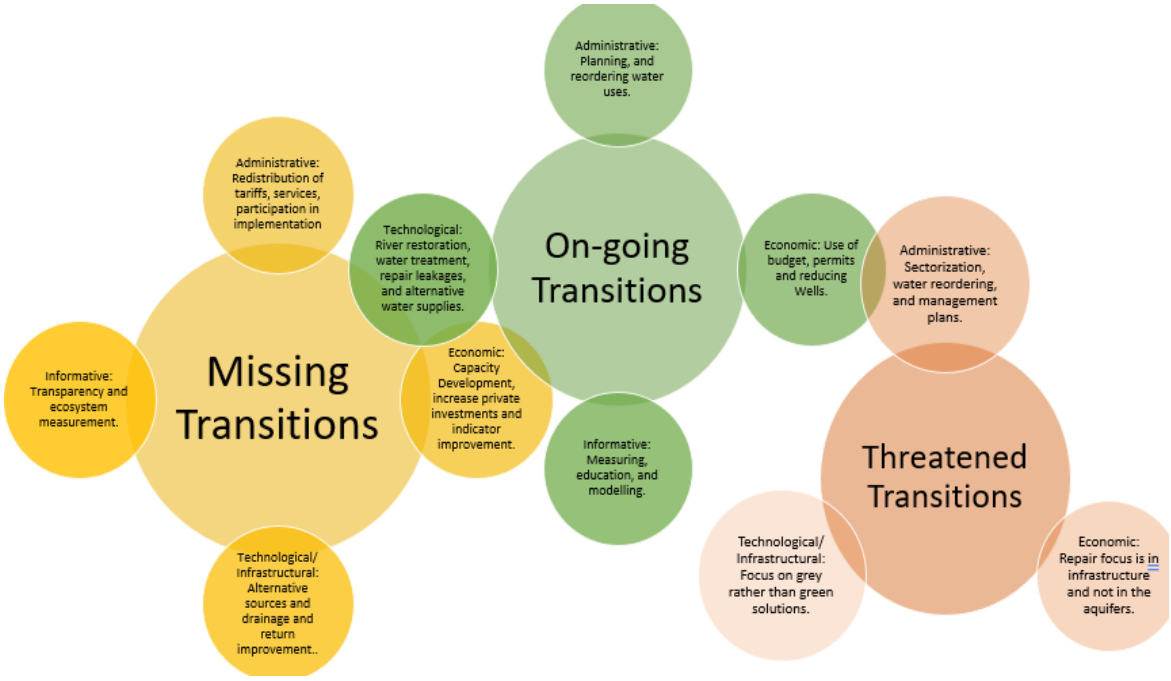

Figure 4-9 – Policy's Instruments for Sustainable Transitions
Source: Own creation.

4.3.4 Policy's Outputs Evaluation

The **sustainable evaluation** of the **outputs** will be described in *Table 4-16*. It describes the current situation of the results of what has been done in the policies, in the law, and the current situation ecologically.

Table 4-16 – Policy Outputs Sustainable Evaluation of Mexico City's Water Policies

	Status Quo	Socio-Ecological Sustainability Model	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect - Limit of Freshwater Resource Use**
Outputs (Table 4-1, Table 4-4, and Table 4-6)	-Planning documents. -Improvement of the quantity, pressure, and quality of the water in 16 municipalities. -Rehabilitation of wells -Policies for water leakages. -Two water treatment plants construction. -Sectorization division. -Tube's substitution. -Basin's recovery conservation projects.	There have already been demands for not complying with water right access. Thus, there is a way to demand the right, but also a failure to guarantee the right of discriminatory service, conflictual water uses, and what to do when tariffs are not paid.	There is a deficit of 507.230 million annual cubic meters for water use. There is a hydrological model that gives what variables could be included in the basin's understanding.

Source: Own creation.

From the table, we can observe that the output elements for a sustainable transition that are taken into consideration are the ones in *Figure 4-10*:

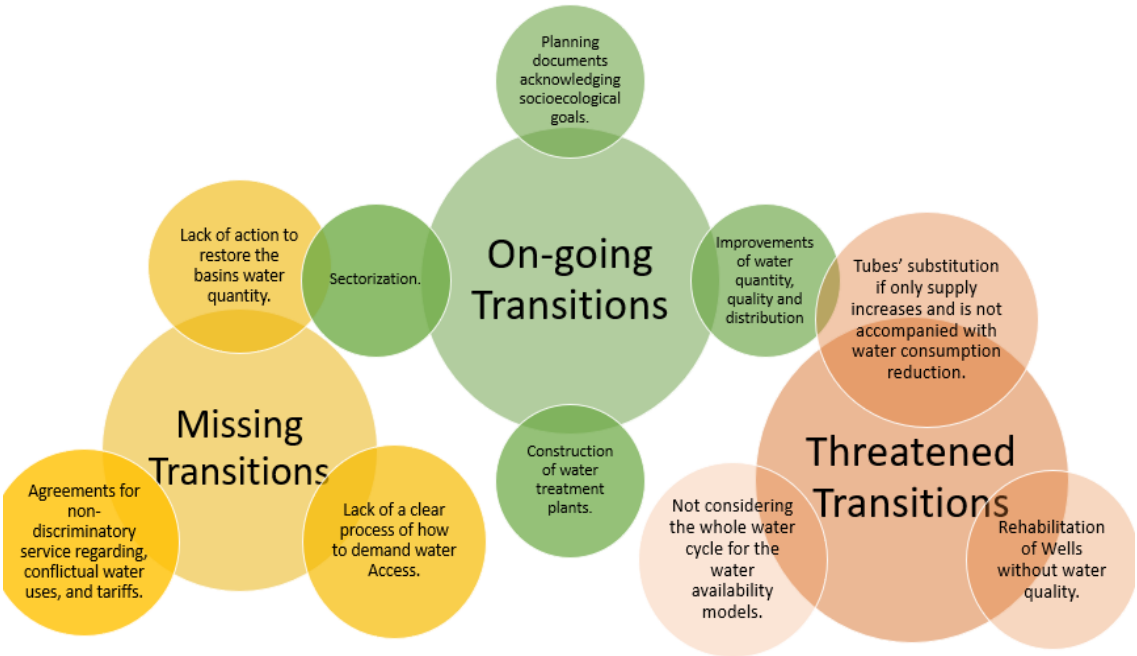

Figure 4-10 Policy's Outputs for Sustainable Transitions
Source: Own creation.

4.3.5 Policy's Effects Evaluation

The **sustainable evaluation** about the long-term purposes for creating the policies also called **effects** will be described in *Table 4-17*:

Table 4-17 – Effects' Sustainable Evaluation of Mexico City's Water Policies

	Status Quo	Socio-Ecological Sustainability Model	
		Social Aspect - Guarantee of Human Right to Water	**Ecological Aspect - Limit of Freshwater Resource Use**
Effects (Table 4-1, Table 4-4, and Table 4-6)	Integral Management for the Hydrological Resources	**Water Justice** meaning guaranteeing the right for all Mexico City's inhabitants for today's inhabitants and future inhabitants.	**Water Security** meaning that there is holistic management of water that recharges the water to the ecosystem, protecting the stability of the Panuco, Lerma-Santiago Basins, and the basins where Mexico City imports water from.

Source: Own creation.

From the table, we can observe that the theory of change's *effect* elements for a sustainable transition that is taken into consideration are the ones shown in *Figure 4-11*:

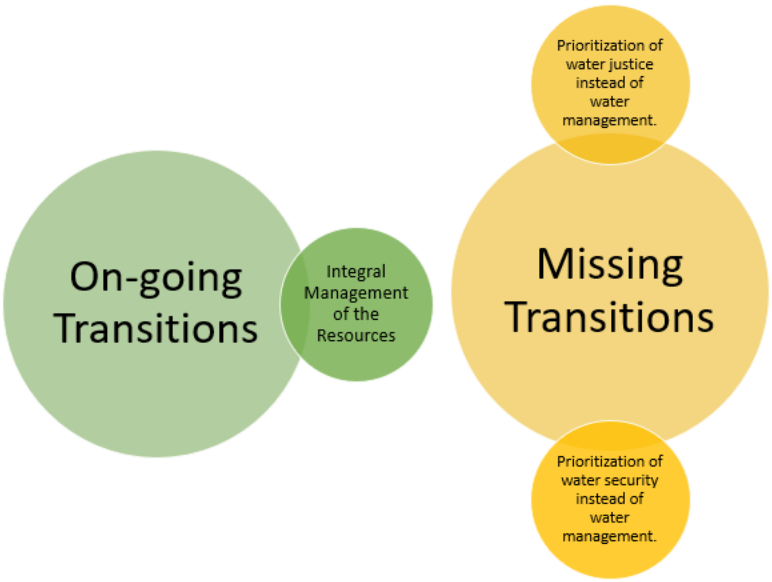

Figure 4-11- Policy's Effects Sustainable Transitions
Source: Own Creation

It must be noted that there are no *effect* elements that are threatening the sustainability transitions.

4.3.6 Analysis about the sustainable transitions in Mexico City's Water Policies

From the theory of change above we can see that there are then three different processes of sustainable transitions for Mexico City's water policies:

1) *Ongoing Sustainable Transitions (Sustainable Transitions in place).*
2) *Missing Sustainable Transitions (Not yet in place).*
3) *Threats to sustainable transitions (Contradictory measures towards a sustainable transition).*

Each of these Mexico City's sustainable water transitions will be summarized below:

4.3.6.1 Ongoing Sustainable Transitions

There are some elements of Mexico City's water policies that are already transiting towards sustainability. Some of these transit towards the social foundation's border, others for the environmental ceiling border, and some towards both borders of the socio-ecological sustainable model as can be seen in *Figure 4-12, 4-13, and Table 4-18* below:

a) Policies that transit towards the social foundation is shown in *Figure 4-12 :*

Figure 4-12 - Policies with a social sustainable transition
Source: Own creation.

b) Policies that transit towards the environmental ceiling is shown in *Figure 4-13:*

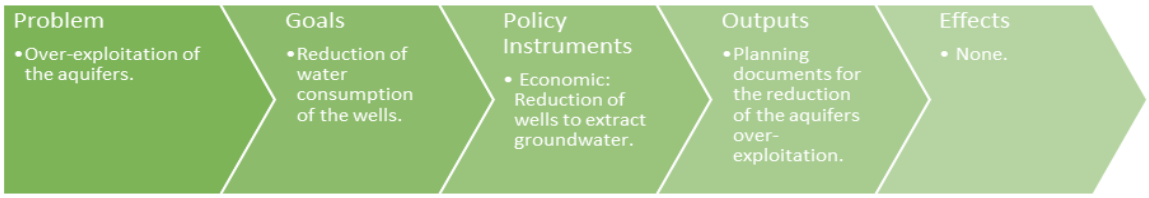

Figure 4-13 – Policies with an ecologically sustainable transition
Source: Own creation.

c) Policies that transit towards both sustainable borders are shown in *Table 4-18:*

Table 4-18 – Policies that transit towards both sustainable transition borders

Problem	Goals	Policy Instruments	Outputs	Effects
Required infra-structure maintenance.	None.	*Administrative:* -Creating water sectors. -Reordering water uses. -Creating programs and management plans.	Improvements of the water quantity, quality, and distribution of water in the municipalities. -Two water treatment plants. -Sectorization division in progress.	Integral Management of the Resources.
		Economic: -Use of public budget. -Use of concessions and assignations.		
		Informative: -Doing macro-measurements and telemetrics. -Educating for water culture. -Creating academic-based models in the master plans.		

	Infrastructure/ Technological: -Restoring rivers. -Increasing water treatment. -Reducing water leakages. -Creating alternative water supply projects.		

Source: Own creation.

Moreover, these sustainable transition elements cannot be fulfilled at the same time. Some elements depend on one another. As the SACMEX's policy-maker Gonzalez(H. González Broc, personal communication, April 15, 2021) noted, the policies are a reiterative process of finding problems, solutions and then adapting the solutions to the new problems faced. Hence, the results show there are still three stages in June 2021 for Mexico City's sustainable water transition required to get to the sustainable borders of the system (*Figure 4-14)*:

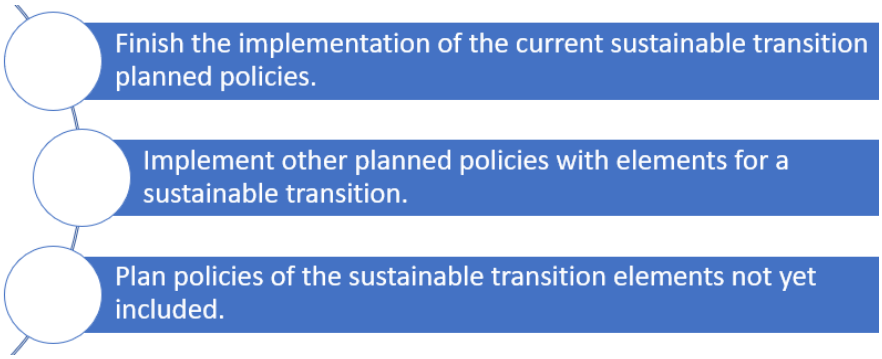

Figure 4-14 - Mexico City's Sustainable Transition Stages
Source: Own creation.

Hence, this shows that if we apply the doughnut to Mexico City's sustainable transitions, the transition stages should be also added to Raworth's doughnut (2017) as seen in *Figure 4-15*:

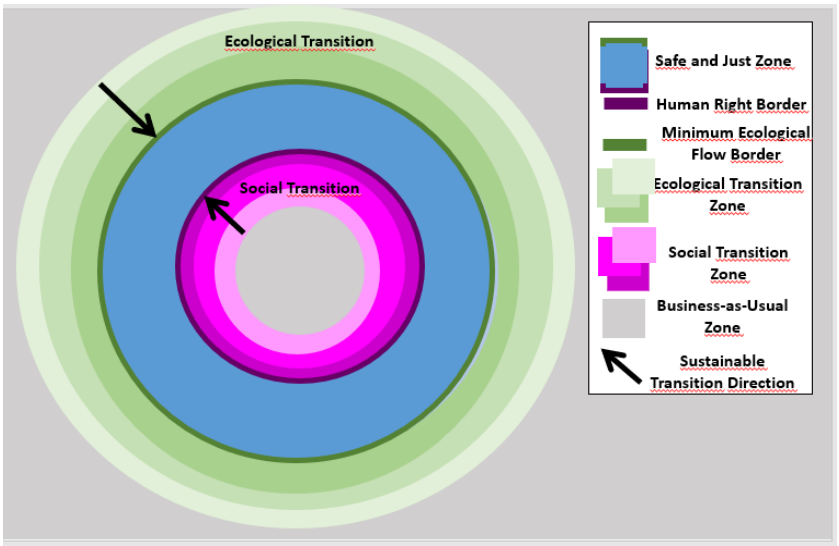

Figure 4-15 - Sustainable Transitions Doughnut
Source: Own creation.

From these, the data suggests that there are already several transition processes in the current policies. However, there are also some other elements of the policies that have not included the elements towards this transition as will be observed below. Moreover, that there is the existence of some solutions that are not only social or only ecological, but both at the same time.

4.3.6.2 Missing Sustainable Transitions

There are some elements of the sustainable criterion of Mexico City's human right to water and from its ecological border that are not yet included in the policies. Therefore, the elements shown in *Figure 4-16,* show the elements of the transition that are still not taking place, but that require some transition changes in the policies.

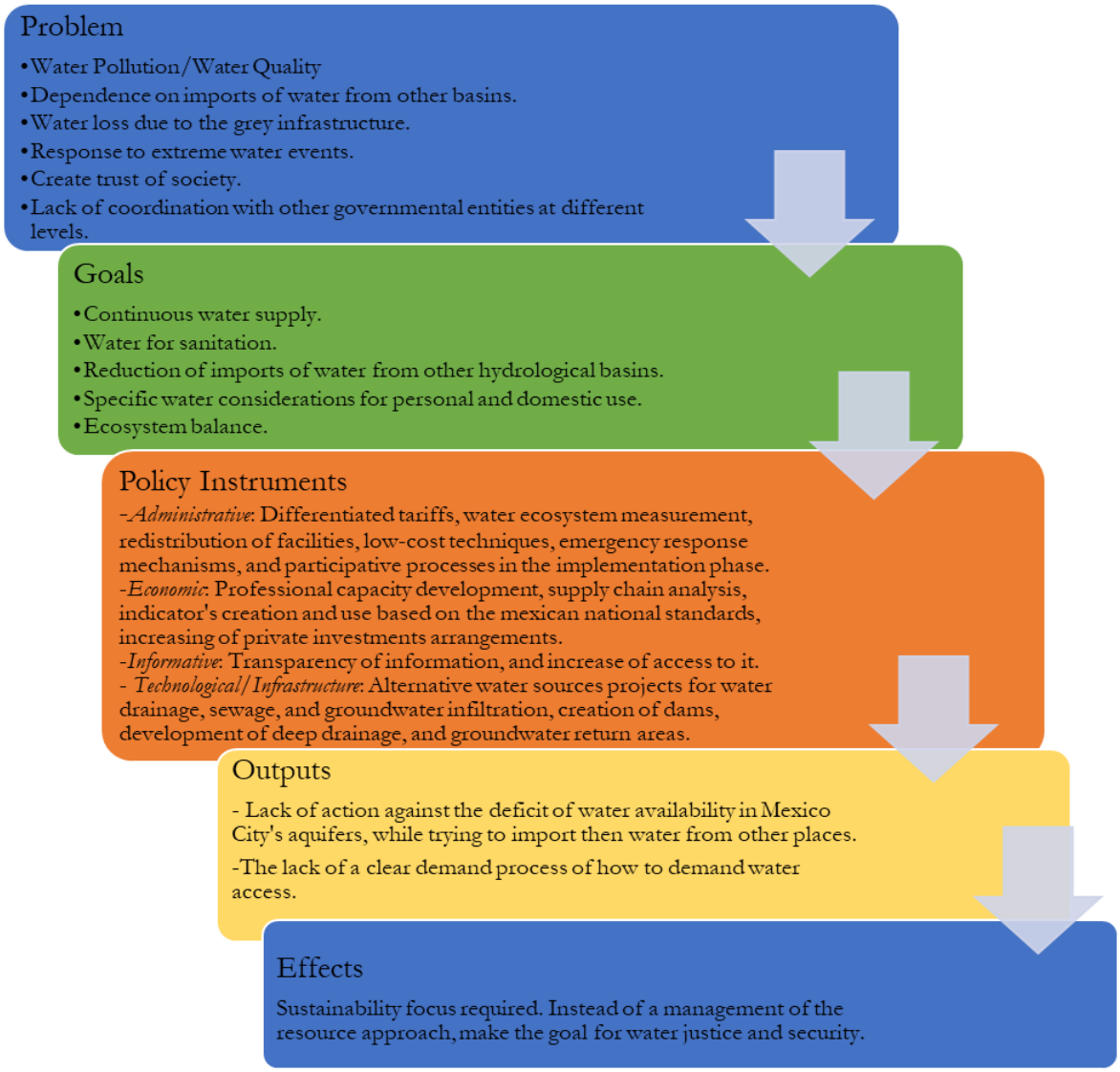

Figure 4-16 - Theory of Change for Missing Sustainable Transitions
Source: Own creation.

These are the missing sustainable transition elements in the policies from the socio-ecological model of the system. Therefore, these elements should be included in the policies for there to be a sustainable transition of Mexico City's water system. These elements show what criteria have been ideologically or naturally required but not yet achieved.

To understand further the missing transitions, these results will be analyzed against the seven ways to think in the 21st century by Raworth (2017). These will show more clearly what Raworth's (2017) mindsets are that still require a change in Mexico City's water system policies, as shown in *Table 4-19* below.

Table 4-19 – Raworth's Sustainable Transition Principles

Raworth's Sustainable Transitions Principles	Degree in Policies	Reason for the Degree
Change the Goal	✓	Policies have changed from a focus on an infrastructure goal to socio-ecological goals: guaranteeing the human right to water and reducing the over-exploitation of the aquifer.
See the Big Picture	◌	They have decided now to measure water in new sectors to understand the precise social and ecological challenges in the city. However, they have not acknowledged the need to restore the aquifers as a goal.
Nurture Human Nature	◌	They have acknowledged the importance of working with citizens and coordinate locally among sectors. However, trust from the citizens is missing, and it is missing to coordinate with the national level and with other sectors including energy and climate change.
Get Savy with the Systems	✗	There is no socio-ecological analysis of the system that can show the possible positive feedbacks in the water system towards a sustainable transition.
Design to Distribute	◌	They have acknowledged the distribution problem and are now measuring in new sectors to improve water distribution. However, the city still has different levels of water access services and quantities.
Create to Regenerate	◌	There is now the development of some infiltration projects. However, there has not yet been an implemented solution that includes increasing infiltration of rain water to the ground.
Be Agnostic with Growth	✓	There is mainly the goal of being self-sustained regarding water resources in Mexico City.

◌ (Progress) ✓ (Fulfilled) ✗ (Required)

Source: Own creation.

Therefore, the sustainable transitions are still missing to change the mindsets of: see the big picture, nurture human nature, get savvy with the systems, design to distribute, and create to regenerate.

4.3.6.3 Threats to Sustainable Transitions:

Finally, there are also some of the elements of the policies that are taking the policies farther from the sustainable transition process. Therefore, it is taken the current *BAU* farther from sustainability. The elements of the policies that are then threatening a sustainable transition are shown in *Figure 4-17* below:

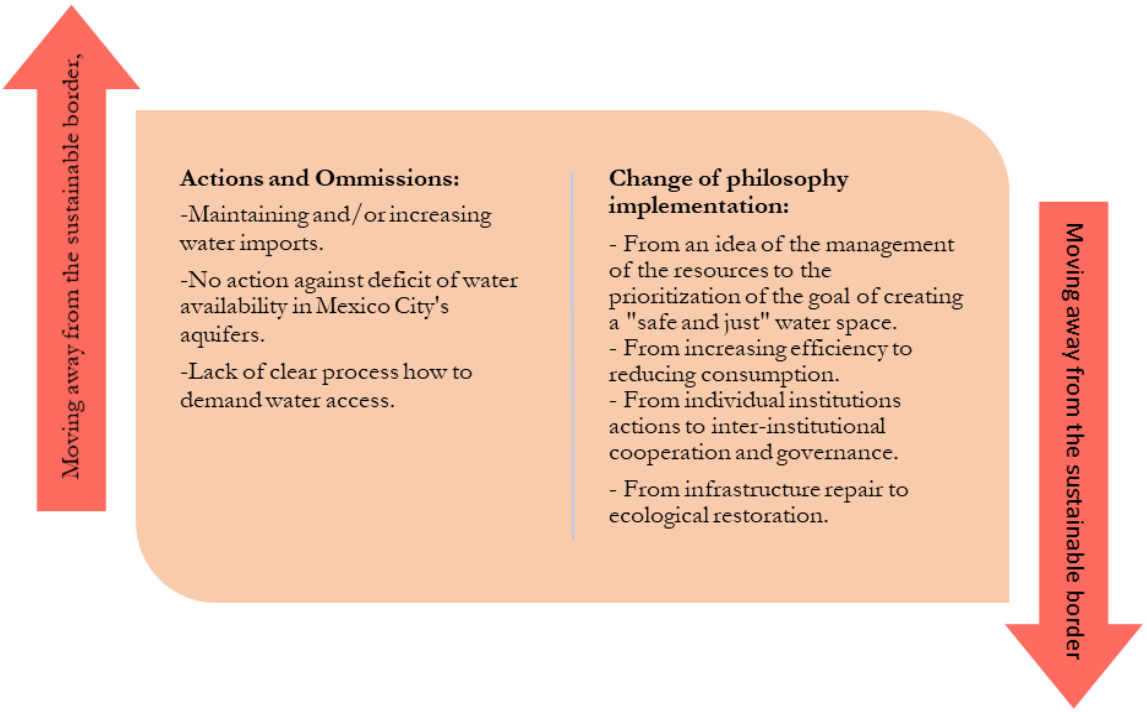

Figure 4-17 - Threats to Sustainable Transitions
Source: Own creation

4.3.7 Evaluation Conclusion of the Sustainable Transitions of Mexico City's Water Policy

To evaluate Mexico City's water policy, there was a comparison between the current *BAU* border of the system, with the sustainable border of that same system (by analyzing its social foundation based on the human right to water, and its environmental ceiling based on the minimum ecological water flow). The evaluation was made in a way that it did not only analyze the differences between the *BAU* border and the sustainable one, but also the ongoing and missing transition processes within the system that are moving the *BAU* border closer or farther from the sustainable borders. For this, this evaluation analyzed not only the border, but the theory of change of the current policies as well as of the human right and ecological systems.

The data suggested that after comparing the socio-ecological theory of change and the status quo policies**, some sustainable transitions are already starting in Mexico City's water policies**. **However, they are still not sufficient to reach the sustainability scenario**. This can be shown as there are new long-term integral plans to manage the resource in coordination with different governmental institutions. This plan includes as a first step to increase the water flow information of how the water varies geographically by dividing the city into "sectors", which have the aim to create information that serves to create a self-sufficient distributed system. This system will intend to include as well understanding of how to decrease the over-exploitation of the aquifer. All of these show the intention of the current

government to make a social and ecological sustainable transition. The transition is not a single step, but a multi-step process.

On the contrary, **there are several points of the socio-ecological system that have not yet been addressed in the policies**. Mainly, the research suggests that there is required a greater unification of the ecological perspective as well as a more participatory governance approach. Nowadays, there are no specific ways of how to work jointly between the governmental institutions in different sectors and levels. Moreover, there are still debates about how the governmental relationship with private individuals should be. Thus, this makes an obstacle to increase governance and regulate the relationship and participation of other agents for water sustainability in the system.

In addition, even when the policies are acknowledging the importance of nature-based solutions/green solutions, they have not yet planned or implemented them. Instead of considering ways to regenerate the groundwater flow in Mexico City, they are trying to maintain the exploitation of this groundwater and continue to import water from other aquifers. Therefore, some mitigation solutions of how not to reduce the water quantity and quality of the aquifers are required still in the policies to be regenerative. Also, due to the quantity of water and number of people in the city they are still not assuring all the characteristics of the human right to water required in the Constitution. Thus, according to Raworth's framework, it can be seen how there is the beginning of a change of mindset to transit the policies towards sustainability, but there are various elements still in progress.

Finally, **there are some elements in the policies that threaten to move the direction of the system against a sustainable transition**. These include some actions and omissions of the government, as well as some actions that could have side effects against the transition. Even when it is starting a change of philosophy, and there are already policies going towards a sustainable direction, there are others that are keeping the *BAU* border in the same place: no focus of reduction of water consumption, and missing solutions for aquifers restoration, and self-sufficiency with no imports of water from other basins.

In conclusion, this evaluation showed there exists a partial sustainable transition for the water policies of Mexico City. There are some projects in place that should be maintained or implemented, but there are some other contents that should be now also included in the policies.

5 Discussion

5.1 Discussing your results against that which was already known

There were three main areas of results in this research:

- Creating a **Sustainable Transitions Scenario for Mexico City's Water** by downscaling the sustainability approach given by the Doughnut Economics Model of Raworth (2017).

- Creating a **methodological policy tool** that can show the elements of how **policies can transit from the status quo to the Sustainable Transitions Scenario of their systems**, by analyzing comparatively the policies' status quo theory of change and the one required for the sustainable transitions scenario for Mexico City's water system.

- Show the **degree to which the current policies are including the elements to transit towards the sustainable model**.

These three areas will be more thoroughly described below.

5.1.1 Sustainable Transitions Scenario for Mexico City's water system

This research applied Raworth's global socio-ecological model of the doughnut into Mexico City's water socio-ecological system. It analyzed Mexico City's water system's elements, interactions, and feedback loops. It didn't study the specific stocks and flows due to time constraints. Before, the doughnut economic model had already been applied to cities and had made important developments in cities in Europe and the United States. However, it had not yet been applied to specific sectors within the systems, and it had not yet been applied to Mexico City's case. Therefore, this research show how it is possible to contextualize this model in Mexico, to Mexico City, to specific sectors such as water, and include human rights as its social foundation instead of policies. It showed how policies could be used as an instrument instead to reach the sustainable borders of the system.

This research showed the sustainable borders of Mexico City's water system, by downscaling the doughnut to the sector scale. It gave a clear definition of what the sustainable goals of the system are, which could be the goals for sustainable policies. Instead of leaving sustainability as a general abstract concept, it gave the concept concrete characteristics for Mexico City's water system case.

The sustainable borders of Mexico City's water system in this research were found to be: the human right to water as the social foundation border of the system, and the minimum ecological flow as the environmental ceiling border of it. Instead of using the policies as the social foundation, as it is done at the planetary level, it was shown that law can serve as a longer-term social foundation, as it does not depend on the political will at the time. The results showed this because the legal framework of the human right to water gave greater knowledge of the agreed-on working system in place. However, some legal frameworks should also be improved themselves, to be a better basis for a sustainable transition.

Moreover, regarding the minimum ecological flow, this research showed three points. First, that there is a great array of academic ecological models that do not necessarily translate into officially recognized models. For example, there is no official indicator that includes an

integral water cycle perspective of the hydrological basins of Mexico City. Second, even when there is not an official model like this, it is better to use the official models as a point of comparison as it serves to discuss the policy in these terms. In this case, the minimum ecological flow within the availability of water official indicator. Third, it was learned that to improve the official models, all the measurements of the calculations including the minimum ecological flow should be published. In this way, it would be easier for there to be a scientific debate that improves the knowledge gaps of the official models, without even needing to pay for a consulting service.

In addition, this research showed how there can be stages of sustainable transitions. These stages are needed as some transition elements depend on a previous transition stage such as the measurement of new sectors in Mexico City. Hence, this research proposed the creation of a new doughnut model that includes transition stages. These stages could be social and/or ecological, as some policies favor both types of transitions at the same time, such as repairing the system's infrastructure. These stages are also not unidirectional, as could be observed as there were some elements found in the policies that may threaten the sustainable transitions. Finally, the elements in each of these stages could be understood as feedback loops. Thus, they do not lead to static *doughnut* borders, but towards certain dynamic zones. This is seen in *Figures 4-15* in the doughnut economic model applied to Mexico City's Water System. Finally, it was found that even when Raworth's theory highlights the borders of the doughnut, it is better to observe the doughnut in zones.

5.1.2 Policy tool to transit towards a sustainable model of the system

In the Doughnut Economics Model, policies are the social foundation border of the socio-ecological systems. However, in this research, there was an assumption that the policies could be used instead as the transition tool to move the *BAU* borders into sustainable ones. For this reason, the 2018-2024 current governmental policies were analyzed, and evaluated to know the missing gaps in the policies to make this sustainable transition. It was found that the policies are indeed a way to achieve sustainable transition because they are done by the State (as the main responsible agent), and that a policy evaluation could understand the missing gaps.

This research's findings show the importance of understanding the logic, and causal relationship in the policies for a sustainable transition. Even when there seem to be simplified documents that include all the policies made by one public institution with sustainable goals, the policies are a combination of different governmental problem definitions, plans, and actions to move things through. Therefore, this research suggests that not only the sustainability goals have to be maintained, but also the integrated process of the policies is required. This logical understanding of the policies analyzes then what are the aligned and non-aligned priorities for sustainable water in Mexico City. It shows what must be reinforced for a sustainable transition and what are the mechanisms working against this transition. However, even when policies were shown to be a strong mechanism to coordinate actors for the sustainable transition, it also showed that policies are not the only instrument to make sustainable transitions. There are some legal instruments and some other technological innovation projects that can also serve to support the sustainable transitions without government action been required.

This policy evaluation included a sustainable criterion, instead of a social one as it was done in a previous 2012-2017 Mexico City's water evaluation. This evaluation also focused on the system's elements and the logic of its movement to know how these could be strengthened for a sustainable transition. In comparison, the previous evaluation was made to understand the

substantive and operative characteristics required to give equal access to water. Moreover, this evaluation includes an ecological aspect of sustainability that was not included before, and it also addresses the contradictory idea between assuring environmental water protection while guaranteeing its access for all. This evaluation showed how there are ways to evaluate sustainability, and how there are different mechanisms that can move the direction towards the sustainable borders of the system that are not necessarily contradictory to each other such as rainwater catchment.

Finally, it also gives areas of opportunity for change in the logic of the policies, and in policies through time by using the theory of change analysis. Inside this theory of change that has been used in impact evaluations previously, this research shows the importance of including the problem definition that shows the system's borders as another element of the chain, to understand what is the baseline from which the policies are trying to make changes. Also, it includes the two separate elements of: *goals* and *effects* of the policies. These codes were useful for understanding the difference between the system's elements and its general principles. Therefore, it proposes an applied theory of change that combines different elements observed in the different policy tools used for sustainability, and the ones that are missing in it, to make a more complete theory of change analysis that can be applied for sustainable transitions.

5.1.3 Mexico City's Transition Stage to a Sustainable Water System.

This research shows how the current Mexico City policies of 2018-2024 are now starting to change the philosophy of more holistic management of the water resource that includes social inclusion and environmental protection values. Even when there are still many social and environmental challenges that the water policies had not yet faced, there has been a change of philosophy in the current administration to plan how to make the inclusive and "green" solutions required for sustainability. However, there are still many people in society, even interested in the water sector, that have not acknowledged this change of philosophy that is now shown in this research. Thus, there is the need to increase communication about the achievements of the policies as well. Also, interviewers have stated that it is hard to show visible results for water system changes in the short term. Thus, there should be longer-term visible planning of the policies.

This transition of policies towards sustainability borders of the system is very recent, and it shows there has already been a first transition stage of the policies towards sustainability. This is because there is already political will and also the planning of policies that include social inclusion and ecological elements in their planning. However, this research now also showed that a transition will not be achieved if only this first stage is achieved. There are at least two other stages in the water sustainable transition in Mexico City required.

From the results, it was observed that the second stage of this sustainable transition should include: a) working to increase the trust of civilians in the government, and b) increasing the cooperation with other public institutions and with private agents. These were elements that have already been recognized in the policies' plans as objectives, but there are not yet projects that are trying to address these obstacles. Moreover, there are other elements in the new policies' plans that have not yet been implemented that will strengthen a sustainable transition. Thus, its effectiveness depends upon this implementation, too. Today this implementation must also include an understanding of the Covid-19 water requirements and consequences.

Finally, there are other foreseeable steps for the third stage of this transition such as increasing the infrastructure to redistribute the water better and creating policy instruments to reduce the water consumption in Mexico City. These elements are shown by the missing transition

elements from the results, and the missing mindset changes from Raworth's principle sustainable transition analysis. This third stage must include in the policies also the problems that are already acknowledged in the current policies, but where there has not yet been a change of mentality in how to respond to them.

5.2 Reflecting on the results of your study

5.2.1 Methodological/Theoretical/Analytical choices

The methodology chosen was an impact evaluation and the theory was sustainability transitions based on Raworth's Doughnut Economic Model. These choices were made as they had the most practical approaches in their fields.

On the one hand, the impact evaluation was chosen as it did not only answer the question of what the policies are, but also their direction. By understanding the logical process of the policies, this analysis understands the strong and weak points of the policies. Hence, rather than trying to change the policies themselves, it tries to support the current policymakers by stressing the elements that are working and those that could be improved for a sustainable transition. This could give the positive policy feedback loops towards a sustainable transition. The coding used for understanding the theory of change could be also done repeatedly to increase validity of the findings. Otherwise, other methodologies can support the policymakers with different objectives. One example is the strategic environmental assessment, which assesses the effects of policies. Moreover, the input-output analysis and the material flow assessment can give more quantitative results of the policy analysis made. Finally, the multi-criteria decision analysis could support them to choose between alternative policies.

On the other hand, Raworth's theory (2017) was used because it is a joined academic/practical approach that can be contextualized to a particular time and place, and because it shows that sustainability is a process. Instead of understanding sustainability as an abstract concept, it defines sustainability more clearly. Other principles could be used as the criteria of sustainability including the Bellagio Stamp Principles, other systems thinking approaches, and the integrative sustainability concept of the Helmholtz Association. The first two principles could be also contextualized in a particular time and place but are prioritizing other aspects of sustainability. In comparison, the integrative sustainability concept gives clear notions of what is required. However, it already has certain assumptions of what sustainability is. Thus, this concept is harder to adapt to different times and places. Finally, the SDGs could have been used as the internationally agreed development of the city. However, they are a quantitative general indicator that does not give precise information about the problems that need to be addressed in Mexico City's particular place.

5.2.2 Legitimacy

Mexico, and in particular Mexico City has been interested politically to implement the sustainable development agenda. Sustainable Development has been recognized even in the constitutions at the national and local level (Estados Unidos Mexicanos, 2021; Gobierno de la CDMX, 2017), as a proposal for transformative change that can lead to increased well-being. However, in the policies, there has not been a clear understanding of what does sustainability and sustainable development means at the local level in sectors such as water. Therefore, this creates uncertainty in the understanding of what that would entail, and whether a change is happening. For this reason, this research question tries to give a concrete definition of what the sustainable borders of the water system in Mexico City would look like. Also, it aims to

understand what are the steps that are taken today by the policies that can get closer to that goal. However, this research evaluation is done in the middle years of the governmental policies. Therefore, it is harder that this research will be useful to choose alternative policies, as the planning process is already finished, but it can strengthen the existing and future ones.

5.2.3 Sensitivity Analysis

To understand Mexico City's water system and to model its sustainable borders, this research used Kate Raworth's understanding of a sustainable system and included socio-ecological borders to it. These borders are not always clear and defined as Raworth states. However, there are many other systems thinking approaches including socio-technical and socio-institutional ones that could be used instead. Also, there are other socio-ecological models of the system that could define more specific actions to work on for the policies. This research gave then a general understanding of the systems, by including what Raworth's Doughnut Economic Model defines as the minimum elements of the system required for sustainability. It gave then a simplified view of the complex Mexico City's water system. Moreover, instead of using the policies as the social foundations of the socio-ecological system, as Kate Raworth suggested, this research used the legal framework of Mexico City's water. Thus, as the policies were not chosen as the social foundations, it gave a non-biased approach for their evaluation. However, not only human rights could have been used as the social foundation. There could have been other foundations identified by other disciplines such as culture and social identity, but this would not have been compulsory norms within the social system.

5.2.4 Generalization

There are some elements of the results that can be generalizable and some that cannot be. One element that can be generalizable of this research is the methodology of how to translate the planetary boundary to an urban boundary in a specific sector. The way to do the analysis could be done with other case studies, to model other socio-ecological systems and propose then sustainable water transitions in policies. This is because the methodology in this research allows understanding the *BAU* and sustainable borders of the system, as well as the legal and ecological characteristics of it, that could help the system to transit towards sustainability. Therefore, this methodology could be used for other locations and moments in time, in other cities in Mexico and around the world.

Another element that can be generalizable is to use the social foundation of the doughnut as human rights instead of using the SDG policies. In other words, the human right recognized by each location, in this case by Mexico City's water legal framework, cannot be generalized. However, the idea of using human rights as a social foundation can be generalized.

Moreover, some elements of the sustainable borders of Mexico City's water system could be generalized. On the one hand, the international human right criteria for water could be generalizable for other water socio-ecological system understandings, in places where they have accepted this international human right water definition. Also, the national criteria of the human right to water could be the social foundation for other sustainable evaluation of cities in Mexico.

On the other hand, there exists the official water availability and the minimum water flow calculations for Mexico City, but there are also calculations done at the regional and national levels. Thus, these indicators for the ecological borders could then also be used as the ecological criteria for other cities in Mexico.

6 Conclusion

After evaluating whether Mexico City's 2018-2024 water public policies were transitioning towards sustainability, it was found that: a) Mexico City's policies are taking the first steps to transit towards sustainability, and b) Raworth's model can be used to analyze the socio-ecological system of governmental sectors, and c) impact evaluations serve to understand the movements of the elements of a system for a sustainable transition in policies.

Therefore, in the first part of this chapter, the specific answers to the research questions that drew those three conclusions are summarized. Then, the second part of these conclusions explains the ideas for policy recommendations that were drawn from the elements of the evaluations' theories of change. Finally, the research found some gaps of knowledge when trying to understand Mexico City's socio-ecological system. Therefore, these recommendations for future research are described in the third part of these conclusions.

6.1 Summary of Research Answers

This thesis aim was to **evaluate whether Mexico City's 2018-2024 water public policies are transiting towards sustainability.** This research was made by using an impact evaluation methodology based on Raworth's sustainability transition understanding, combined with a policy theory of change analysis. With this methodology, the following results were found:

It was found, to answer the RQ1: **What are Mexico City's 2018-2024 water public policies?,** that there is at least one policy document for water for each of the governmental institutions in charge of the water management of Mexico City. There are also federal and local institutions in charge of planning and implementing these policies in the city. These are: CONAGUA, the Basin's Commission, SEDEMA, and SACMEX. There are mainly two goals for these policies: "guarantee the human right to water for all" (at least in a non-continuous way), and "reduce the overexploitation of the aquifer". The mechanisms that try to implement these policies include: infrastructure repair and maintenance, new divisions for measuring the ecological water flows, and new alternatives for water supply.

It was found, to answer the RQ2 of **"What can be the socio-ecological criteria, based on Raworth's Doughnut Economic Model, to evaluate whether Mexico City's 2018-2024 water policies are transiting to sustainability?"** that there are two main criteria that can be used to evaluate Mexico City's water policies according to Raworth's model. These criteria create a sustainable transition model/scenario for Mexico City's water system. The first criterion is based on the social foundation border of the system, that is, the human right to water recognized by Mexico City's legal framework based on Article 4 of the Mexican Constitution and Comment 15 of the General Assembly. The second criterion is based on the environmental ceiling border of the system, that is, the minimum ecological flow of Mexico City's water system, which is a calculation that is part of the availability of water indicator. However, this research shows that it is not sufficient to only understand the border of the socio-ecological system to evaluate its policies. Therefore, the criteria chosen was the theory of change of the legal and ecological criterion to transit towards sustainability.

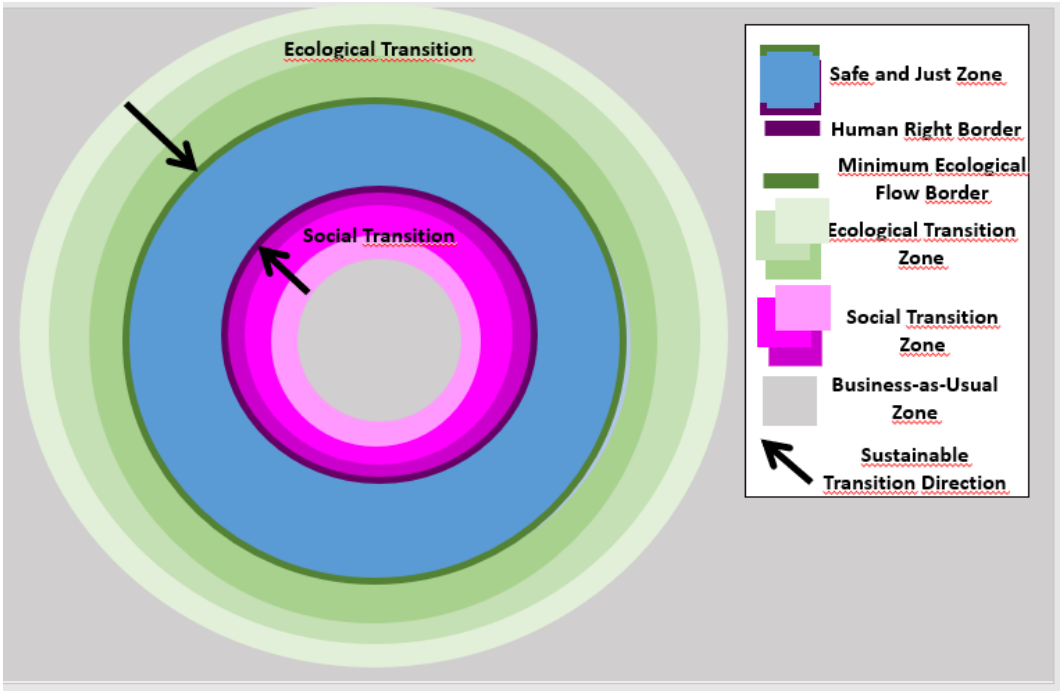

Figure 6-1 - Sustainable Transitions Doughnut
Source: Own creation.

Finally, the answer to the RQ3 of "**What is the sustainable transition state of Mexico City's 2018-2024 water public policies?",** is that there are ongoing transitions, missing transitions to take place, and some policies' elements that threaten the transitions. For this reason, this means that there is a first step towards a sustainable transition, but that there are several steps still required to reach a sustainable transition of the system.

The policy sustainable transition beginning can be very clearly observed as its two main local purposes are: "guarantee the human right to water for all" and "reduce the over-exploitation of aquifers". In addition, some planning documents intend to implement these two goals. However, implementation of the planned policies is still required, as well as to plan other policies in the long-term that include elements for sustainability that have not yet either been planned or implemented. These missing elements include: **reduction of the water consumption, an increase of water infiltration to the aquifers, professional capacity development, transparency of information, projects to improve water quality, dependency on imports from other basins, lack of emergency measures, create trust with society, and coordination between governmental institutions at different levels.**

From these answers to the research questions, it is shown that there is a sustainable transition in place from the *BAU* management of the water resource to more sustainable management of it. However, this transition is not complete. Therefore, the following policy recommendations would be advised:

6.2 Policy Recommendations

The recommendations that are here described are the proposals of what Mexico City's policies could do in each of its transition stages towards Mexico City's sustainable water system. These

recommendations are based on how to strengthen the current policies by using the elements analyzed from the evaluation of the sustainable transition in Chapter 4.3.

The proposals are ideas coming from: a) current Mexico City's water socioecological system mechanisms, b) ideas from the interviewees and c) the analysis of ideas to address the missing sustainable transitions elements that do not have yet policy solution proposals. There were three main transition stages of Mexico City's water system found in this research (shown in *Figure 4-14*). Thus, the recommendations give proposals of how these evaluation elements can be included in the policies for each of these three stages. This will be shown in *Table 6-1,* and more thoroughly described in *Appendix E.*

Table 6-1- Policy Recommendations

STAGE 1 - Finish the implementation of the current sustainable transition planned policies.	**STAGE 2 - Implement other planned policies with elements for a sustainable transition.**	**STAGE 3 - Plan policies of the sustainable transition elements not yet included.**
Finish the macro-measurement of the inputs-outputs of water	**Create trust and partnerships with society.** **Make model scenarios that include the analysis of the water cycle elements of the Pánuco, Lerma-Santiago basin, as well as have this information from the other hydrological basins where Mexico City gets its water from.**	**Create agreements about what can be done when tariffs are not paid.** **Increase projects that include multi-stakeholder investments and participation.**
Prioritize infrastructure maintenance and repair over the creation of new water sources infrastructure.	**Implement the water restoration projects.** **Close the water wells where there is low water quality.**	**Increase of water infiltration to the aquifers.** **Decrease gradually the water imports from other hydrological basins.**
Finish the reordering of the water uses, including promoting water treatment	**Increase the rainwater and treatment water projects.**	
Incentivize future long-term public administrations to continue with a socio-ecological water perspective	**Coordination between governmental institutions at different levels**	**Promotion of the national human rights water law.** **Professional capacity development.** **Transparency of information.**

Source: Own creation.

In conclusion, there are nineteen policy recommendations for the three transition stages that Mexico City's policies require to transit towards a sustainable water system. These three stages include recommendations of what could be done with the ongoing, missing, and threatening elements for the system's sustainable transitions found in this research evaluation. These stages are complementary to each other and require incremental State actions.

6.3 Recommendations for future research

There are several possibilities of future research that were found along with this research regarding sustainability transitions according to Raworth's model, policies as a tool for sustainability transitions, and for the specific Mexico City's water transitions.

6.3.1 Future Research for Sustainability Transitions according to Raworth's Model

This research focused on the planetary boundary and the social foundation related to access to water, and the freshwater resource use ecological limit. This exemplified the possible use of the doughnut at a sector level. However, there are several other planetary boundaries and sectors in the Doughnuts Economic Model that could be also analyzed. For this, the first question would be what other links are between the social foundations and environmental ceilings in a particular time and place. Then, the analysis of one of these sectors could be done as it was done in this research.

There were several links already observed between the water social foundations and the environmental ceilings of other sectors. One example is the one with climate change. Nowadays, there have started to be reports of how climate change will affect water access and sanitation in the future. Therefore, this could be one interesting link to research in different contexts. Moreover, there exists a nexus called the "water-food-energy nexus" that could be another level of analyzing the doughnut according to the three basic needs of humankind. Understanding the links between the social foundations of this nexus and its ecological limits could be a basis to guarantee the basic resource needs with the doughnut model. Moreover, the proposal of this research to use human rights as a social foundation could be used to analyze other levels as well, from the international to the household one.

6.3.2 Future Research for Policies as a tool for sustainability transitions

The current research analyzed the policies of 2019-2024 at their mid-point of implementation. Therefore, future research that analyzes the policies after they have already been implemented, one for the next study, and/or another study through long-term, could be a follow-up of this study. This could show the advances and setbacks of the sustainable transition process in Mexico City, for other cities' learnings.

Moreover, a comparative analysis of possible qualitative and quantitative social foundations and environmental ceilings indicators could be useful. This list could be used to set the goals for the concrete sustainable systems goals in different contexts. The assumption of the current study was to use human rights as the social foundations, and the minimum ecological water flows as the environmental ceiling as it was the official Mexican calculation. It tried to translate the doughnut theory into Mexico City's context. However, a literature review analysis

that showed the possible different sustainable borders of the systems for each sector would be useful as alternatives that different cities could choose from for greater sustainability transitions understanding within their own time and space.

Moreover, it was shown that there are some social, ecological, and socio-ecological projects that policies can do to transit towards sustainability. Thus, there is room for opportunity if instead of planning social or ecological projects, there is an inclusion of projects that can serve both purposes. A careful analysis of what this would be could be done in the future.

Also, it is missing to analyze the solutions proposed and their feasibility in the methodology. Even when these solutions respond to Mexico City's water challenges, it is required to understand the reasons why they have not yet been included and implemented in the policies. The sustainability transition definition and logic of the system were researched in this paper. Now, there is the need to also understand the challenges and opportunities of the solutions. This could create a more concrete tool that would be useful for the policymakers to make or improve the current policies at different scales.

Finally, different policy tools could be applied to sustainability transitions. Thus, as IUCN has made regarding policy support tools and methodologies, there could be an analysis of what are the different policy support tools that could serve policymakers for sustainability transitions.

6.3.3 Future Research for Mexico City's sustainable water transitions

The results showed a clear relationship of the local policies with the national and regional policies. However, there was no clear coordination between them. Thus, an understanding of what this coordination would entail and how to do it would be useful. Also, there is not a clear understanding of what the water policies at the regional level are.

Also, this research missed showing what the quantitative borders of Mexico City's water system are, and what the characteristics are of the *BAU* border. The first for this would be to obtain the data because there is still not sufficient. Therefore, it is missing to understand not only the mechanisms but what the quantitative gap is to transit towards a sustainable system.

Finally, there should be also a further understanding of how to include best each of these policy recommendations into the policies. Each of the policy recommendations has financial, political, social, and ecological constraints that should be analyzed to move from the choice of the sustainable elements of the system to the implementation part of making these projects viable.

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Appendix

Appendix A) Interview Questions

Preguntas para la Entrevista para la Mtra. Jimena Silva
Tipo de Entrevista: Semiestructurada.
Duración de la Entrevista: 60 Minutos.
Fecha: 5 de abril de 2021
Lugar: Zoom Link
Propósito de Entrevista: Conocer su opinión para definir un criterio concreto de límite planetario al agua para una evaluación sustentable de las políticas públicas de agua de la Ciudad de México.

Preguntas:

1) ¿Cuáles son los problemas de agua de la Ciudad de México? ¿Cuáles son los problemas ecológicos?

2) ¿Cuáles modelos hídricos podrían servir para entender y proponer soluciones a este problema? ¿Cuáles son los objetivos de estos modelos?
    - ¿Existen análisis que analicen el cambio del flujo del agua? (Elementos cantidad, tiempo, duración, frecuencia y calidad de agua)
    - En caso afirmativo, ¿se ha analizado a través del tiempo?
    - En caso afirmativo, ¿cómo ha cambiado el flujo de agua en la Ciudad?

3) ¿Cuáles soluciones ambientales existen científicamente para resolver estos problemas?
    - ¿Cuáles son los objetivos de estas soluciones?
    - ¿Qué mecanismos/instrumentos se utilizan para estas soluciones?

4) ¿Qué resultados y efectos se buscaría para una política pública desde un punto de vista ecológico?

5) ¿Qué se requeriría para lograr estos resultados dentro de la política pública? ¿Qué apoyos o agentes se requerirían para el cambio?

Preguntas para la Entrevista para la Mtra. Leticia Gutiérrez Lorandi
Tipo de Entrevista: Semiestructurada.
Duración de la Entrevista: 60 Minutos.
Fecha: 13 de abril de 2021, 10:00 am (Tiempo de la CDMX)
Lugar: Zoom Link https://lu-se.zoom.us/j/63782943306
Propósito de Entrevista: Conocer los aspectos de sustentabilidad incluidos dentro de la política pública actual del agua en la Ciudad de México, en particular del Programa Ambiental y de Cambio Climático para la Ciudad de México 201-2024.

Preguntas:

1) ¿Cuál fue el **diagnóstico** inicial de los problemas de agua en la Ciudad de México para la política pública? En particular ¿cuál fue el diagnóstico para el Programa Ambiental y de Cambio Climático para la Ciudad de México 2019-2024?
2) ¿Cuáles fueron las **propuestas** del Programa Ambiental y de Cambio Climático para resolver los problemas observados en el diagnóstico? ¿Cuáles eran sus objetivos?
3) ¿Cuáles son los **mecanismos** que incluye el Programa Ambiental y de Cambio Climático para poder implementar estas propuestas?
4) ¿Cuáles han sido los **resultados** hasta ahora obtenidos?
5) ¿Cuáles serían los **efectos** a corto-mediano-largo plazo buscados con estas propuestas?
6) ¿Qué **faltaría** todavía para lograr de los objetivos planteados al final de implementar estas políticas públicas?

Preguntas para la Entrevista para el Ing. Héctor González Broc

Tipo de Entrevista: Semiestructurada.
Duración de la Entrevista: 60 Minutos.
Fecha: 15 de abril de 2021, 8:30-9:30 am (Tiempo de la CDMX)
Lugar: Zoom Link https://lu-se.zoom.us/j/69330857265
Propósito de Entrevista: Conocer los aspectos de sustentabilidad incluidos dentro de la política pública actual del agua en la Ciudad de México, en particular del Programa Estratégico para Garantizar el Derecho al Agua, y los programas desarrollados por SACMEX.

Preguntas:

1) ¿Cuál fue el **diagnóstico** inicial de los problemas de agua en la Ciudad de México para la política pública? En particular ¿cuál fue el diagnóstico para el Programa Ambiental y de Cambio Climático para la Ciudad de México 2019-2024?
2) ¿Cuáles fueron las **propuestas** del Programa Ambiental y de Cambio Climático para resolver los problemas observados en el diagnóstico? ¿Cuáles eran sus objetivos?
    - ¿Por qué fueron estas propuestas elegidas?/¿Porqué se jerarquizaron estas propuestas sobre otras?
3) ¿Cuáles son los **mecanismos** que incluye el Programa Ambiental y de Cambio Climático para poder implementar estas propuestas?
    - ¿Cuáles son las dificultades de estos mecanismos?
    - ¿Existen alternativas a éstos?
4) ¿Cuáles han sido los **resultados** hasta ahora obtenidos?
5) ¿Cuáles serían los **efectos** a corto-mediano-largo plazo buscados con estas propuestas?
6) ¿Qué **faltaría** todavía para lograr de los objetivos planteados al final de implementar estas políticas públicas?

Preguntas para la Entrevista para el Dr. Jaime Fernando Cárdenas Gracia

Tipo de Entrevista: Semiestructurada.
Duración de la Entrevista: 60 Minutos.
Fecha: 2 de abril del 2021
Lugar: Zoom Link https://lu-se.zoom.us/j/66254925243

Propósito de Entrevista: Conocer su opinión para definir un criterio concreto de derecho humano al agua para una evaluación sustentable de las políticas públicas de agua de la Ciudad de México.

Preguntas:

1) ¿Cuáles son los antecedentes o causas por las cuales se buscaba incluir el derecho humano al agua en la Constitución Política de los Estados Unidos Mexicanos?
2) ¿Cuáles son las características del derecho al agua que fueron aceptados para ser incluidos en la Constitución, y cuáles son los elementos aún debatidos?
    a. ¿Cuál sería el problema en México a resolver?
    b. ¿Cuál sería entonces la propuesta de este Derecho Humano para resolver este problema?
    c. ¿Cuáles serían los mecanismos o instrumentos que tiene el Estado para garantizar este derecho humano?
    d. ¿Cuáles serían los resultados que busca este derecho que ocurran? ¿Qué acciones se busca que el Estado realice?
    e. ¿Qué efectos de corto y largo plazo busca este derecho humano dentro de la política pública?
3) ¿Cuáles son las responsabilidades del Estado frente a este derecho humano? ¿Porqué?
4) ¿Qué otros elementos del derecho humano al agua podrían servir para evaluar las políticas públicas de agua en la Ciudad de México?

<u>Preguntas para la Entrevista para el Dr. Luis Bojórquez-Tapia</u>

Tipo de Entrevista: Semiestructurada.
Duración de la Entrevista: 60 Minutos.
Fecha: Viernes 16 de abril de 2021, 11:00am (Hora de la CDMX)
Lugar: Zoom Link https://lu-se.zoom.us/j/66749008791
Propósito de Entrevista: Conocer su opinión para definir un criterio concreto de límite planetario al agua para una evaluación sustentable de las políticas públicas de agua de la Ciudad de México.

Preguntas:

1) ¿Cuáles son los problemas de agua de la Ciudad de México? ¿Cuáles son los problemas ecológicos? (**Diagnóstico)**

2) ¿Cuáles **modelos** hídricos de flujos ambientales de agua que podrían servir para entender y proponer soluciones a este problema? ¿Cuáles son los objetivos de estos modelos? (**Propuesta)**
    - ¿Existen análisis que analicen el cambio del flujo del agua? (Elementos cantidad, tiempo, duración, frecuencia y calidad de agua)
    - En caso afirmativo, ¿se ha analizado a través del tiempo?
    - En caso afirmativo, ¿cómo ha cambiado el flujo de agua en la Ciudad?

3) ¿Cuáles soluciones ambientales existen científicamente para resolver estos problemas?
    - ¿Cuáles son los **objetivos** de estas soluciones?
    - ¿Qué **mecanismos/instrumentos** se utilizan para estas soluciones?

4) ¿Qué **resultados** y **efectos** se buscaría para una política pública desde un punto de vista ecológico?

5) ¿Qué se requeriría para lograr estos **resultados** dentro de la política pública? ¿Qué **apoyos o agentes** se requerirían para el cambio?

Appendix B) List of Researched Policy Documents

Scale	***Public Policy***
Local	*a) Government Plans*, that include the initial general government's problem-framing, goals and policy instruments for the water access policies in Mexico City. The government plans are: - Government Program 2019-2024 (Programa de Gobierno 2019-2024) made by the Government of Mexico City. - Environmental and Climate Change Program (Programa Ambiental y de Cambio Climático para la Ciudad de México 2019-2024) made by the Ministry of Environment of Mexico City. - Strategic Program to Guarantee the Right to Water (Programa Estratégico para Garantizar el Derecho al Agua 2020-2024) made by the - National Hydrological Plan (Plan Hidrológico Nacional). - National Development Plan 2018-2024 (Plan Nacional de Desarrollo). - Other problem or geographically focused government plans. The most relevant for this research from these other plans is the: Integral General Plan of Hydrological Resources that is currently been developed by SACMEX. *b) Government Annual Reports* that describe what are the development of the water access issues during the implementation of the government's actions. Sometimes they are directly related to the plans, and sometimes they add or delimit the frame of the problem differently as will be seen below. They are: - First Governmental Report of Mexico City from December 2018-September 2019 (Primer Informe de Gobierno) - Second Governmental Report of Mexico City from August 2019- July 2020 (Segundo Informe de Gobierno) - First Annual Report – Ministry of the Environment (5 december of 2018-31 August 2019) - Second Annual Report – Ministry of the Environment (August 2019- July 2020) *c) Public Budget,* that describe what will be the amount given by the government to the sector and to each of its planned activities. The public budget is included in: - Expenditure Budget of 2019

	- Expenditure Budget of 2020 - Expenditure Budget of 2021
National	- National Development Plan (Plan Nacional de Desarrollo) - National Hydrological Plan (Plan Nacional Hídrico) - First Governmental Report - Second Governmental Report
Regional	There is none.
International	- Agenda 2030. - SDGs 2020. - Joint Monitoring Program for Water Supply, Sanitation and Hygiene

Appendix C) List of Researched Legal Documents

Source of Law	**Legal Document**	**Articles**
Constitution	Mexican Constitution of the United Mexican States (Constitución Política de los Estados Unidos Mexicanos)	Article 4, paragraph 6, 27 Paragraph 1, 73 Paragraph XVII, 115 Paragraph III, 122.
International Treaties	Universal Declaration of Human Rights. Convention on the Rights of the Child Convention on the Elimination of All forms of Discrimination against Women General Comment 15 of the Commission of Economic, Social and Cultural Rights of the United Nations General Comment 3 of the Commission of Economic, Social and Cultural Rights of the United Nations International Covenant on Economic, Social and Cultural Rights.	Article 25 Paragraph 1. Article 24 Article 14. Paragraph 2. Chapter II. Normative Content of the Human Right, Paragraph 11,12, 20. Chapter III. Paragraph 17 and 18. Specific Legal Obligations Paragraph 4. Article 11 first paragraph – Right to housing and food. Article 12 – Right to health

Federal Law	Law of National Water (Ley de Aguas Nacionales).	Article 3 paragraph XVI a and b,, Article 14 bis 5 and 6, Article 22 paragraph 8, Article 29 bis 3 nand 5.
	General Law of the Ecological Balance and the Environmental Protection(Ley General del Equilibrio Ecológico y la Protección del Medio Ambiente)	Article 17 Ter, 22 Paragraph 4, 53 Pragraph 2, 88-97, 117, 121, , 159 Bis, Eight Transitory.
	Federal Rights Law (Ley Federal de Derechos)	Article 192- 192F.
	NMX-AA-159-SCFIE-2012 Mexican Official Standard that established the procedure for environmental flow determination in hydrological basins	Introduction, Normative Appendix C, D and E (Apéndice Normativo C, D, E y F)
Local Law	Mexico City's Political Constitution	Article 9. Paragraph F. Right to water and its sanitation.
	Law for the Access, Disposition and Sanitation of Water in Mexico City (Ley del Derecho al Acceso, Disposición y Saneamiento del Agua de la CDMX	Article 5. Article 9.
Jurisprudence	Jurisprudence 1- VI.3o.A.1 CS (10a.) Jurisprudence 2 – I.1o.A.99 A (10a.) Jurisprudence 3- I.1o.A.4 CS (10a.) Jurisprudence 4- I.9o.P.67 P (10a.) Jurisprudence 5 - I.9o.P.69 P (10a.) Jurisprudence 6 - XI.1o.A.T.1 K (10a.) Jurisprudence 7 - XXVII.3o.12 CS (10a.) Jurisprudence 8 - 2a. XVII/2018 (10a.) Jurisprudence 9 - I.8o.A.132 A (10a.) Jurisprudence 10 - IV.1o.A.66 A (10a.) Jurisprudence 11 - I.18o.A.2 CS (10a.)	

Appendix D) Mexico City's Water Balance

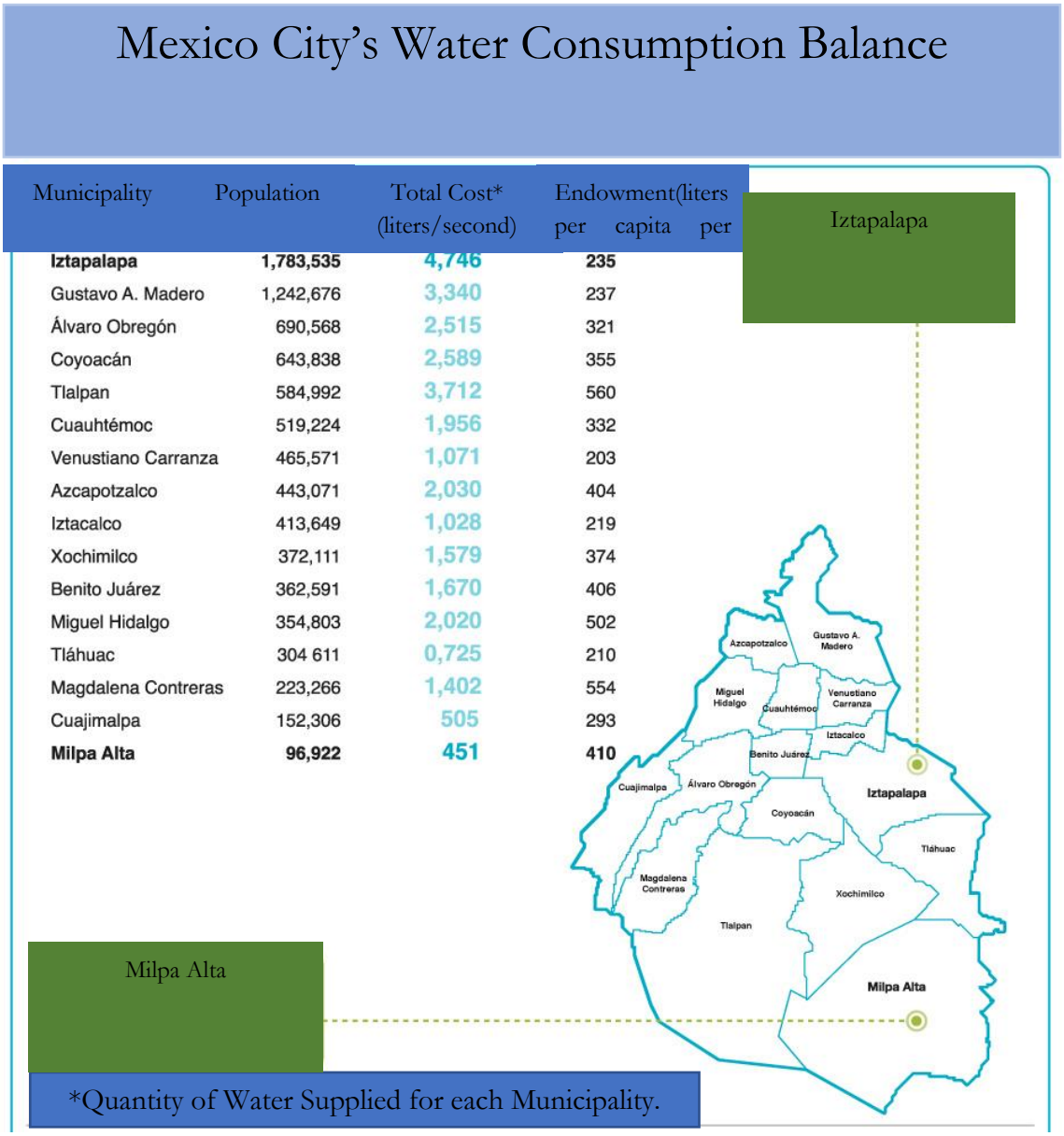

Figure 0-1 - Inequal Water Consumption in Mexico City
Source: Adapted and Translated (SEDEMA, 2021)

Appendix E) Policy Recommendations Extensive Explanation.

A) <u>Finish the implementation of the current sustainable transition planned policies.</u>

1. **Finish the macro-measurement of the inputs-outputs of water** in Mexico City, focusing on where the water is needed for social and environmental purposes.
2. **Prioritize infrastructure maintenance and repair over the creation of new water sources infrastructure.** Make long lasting repairs that can first address the water needs without requiring water from other hydrological basins.
3. **Finish the reordering of the water uses, including the promotion of treatment water uses** to reduce clean water consumption and increase water access for different purposes.
4. **Incentivize future long-term public administrations to continue with a socio-ecological water perspective** by creating strong implementation pillars of the policies that can facilitate future management of the water with the same perspective.

B) <u>Implement other planned policies with elements for a sustainable transition.</u>

5. **Create trust and partnerships with society**. Promoting participation throughout the policy phases, including the planning and implementation phases. Also, a survey could be done that asks about the reasons for the lack of trust and how to resolve them. Moreover, increasing transparency and educational campaigns, could increase trust by giving the information of the chosen policy alternatives, and showing them possible actions that the government could take to increase their participation for solving their water challenges. This would give the citizens the capacity to decide for themselves, for this and future policies. Also, strengthening governmental institutions could be a solution, even when this is a not water-related process.
6. **Coordination between governmental institutions at different levels** by finding the synergies between institutions' faculties. This coordination should not only be local, but with other governmental levels and sectors. For this reason, the proposal is to find the policies that require the capacity of other sectors and institutions and collaborate with them to find solutions. Some relevant sectors for water include the energy and climate change institutions. For this, SEDEMA or SACMEX could make a platform where it invites other relevant institutions to express their concerns and requirements about water, to have joint solutions. This platform design could be based on other previously beneficial inter-institutional platforms.
7. **Implement the water restoration projects.** There are already plans of creating water restoration projects, but they have not yet accomplished positive water return to the aquifer recognized.
8. **Increase the rainwater and treatment water projects,** not only pilot projects but in a greater scale.
9. **Close the water wells where there is low water quality,** to reduce the over-exploitation of the aquifer while giving safer access to water to citizens.
10. **Make model scenarios that include the analysis of the water cycle elements of the Pánuco, Lerma-Santiago basin, as well as have this information from the other hydrological basins where Mexico City gets its water from.** There are some variables of how to conserve the basins more integrally. Thus, the official indicators of water availability could also include the elements of soil moisture, groundwater, atmospheric water, and frozen water if it exists as seen in *Figure 10*.

C) <u>Plan policies of the sustainable transition elements not yet included.</u>

11. **Promotion of the Federal Law** that regulates the Human Right to Water, and the coordination of it between the different authorities.
12. **Increase projects that include multi-stakeholder investments and participation,** to create spaces for different stakeholders to participate within a governance perspective in the water policies, with finance and engagement.
13. **Create agreements about what can be done when tariffs are not paid.** Analysis of the possibilities of what can be done, and in which cases there should be a differentiated tariff, and how to implement these in every similar case.
14. **Promoting water consumption reduction with educational campaigns.** There are already water education campaigns. However, it was not highlighted whether these were focused on reducing water consumption and whether they were addressed to the right audience. After having noted what are the locations and sectors where there is an unequal water distribution, the proposal would be the creation of group-focused educational campaigns to reduce unnecessary water consumption.
15. **Increase of water infiltration to the aquifers.** Even though this was a well-known problem, there were few solutions to address it. There is already an infiltration projects, but it is not clear what actions will be done for it. Therefore, the proposal is to strengthen the already planned solutions to infiltrate the aquifers and find new ways to do so. Some that were mentioned in the interviews were to change the pavement to an asphalt with infiltration characteristics, increase green areas, or create rainwater catchment areas for the city.
16. **Professional capacity development.** There is a change of mentality for the policies, but the training for the relevant authorities has not changed. Moreover, there are some characteristics of the water system that are unique from other countries. Thus, the proposal is to strengthen professional capacity development for these authorities. This training should give information about the concrete characteristics of Mexico City with a new integral management/sustainable perspective.
17. **Transparency of information.** There is not a clear page where one can find the information. Moreover, there seem to be different management organizations between the federal and local governments at the same time. The proposal is to increase the information about these calculations to build trust and to improve these calculations. If they were public, they could be subject to constant non-paid academic analysis.
18. **Coordinate emergency measures.** There are no emergency measures made in coordination with other governmental agencies. Moreover, as there are going to be increasing climate change effects in the next years, these emergency measures will become increasingly important. Thus, the proposal that was given was to start coordinating with other agencies the creation of these pre-emptive measures.
19. **Decrease gradually the water imports of other hydrological basins** by being self-sufficient.